PACT

PARTNERSHIP FOR
CARBON TRANSPARENCY

Pathfinder Framework

Guidance for the Accounting and Exchange of Product Life Cycle Emissions

Version 2.0

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Collaborators

WBCSD would like to thank the following companies and organizations that have supported and contributed to the development of the Pathfinder Framework:

Knowledge partner

McKinsey Sustainability

Technology partner

Contents

Foreword

The world has already warmed by 1.1°C and is falling behind in limiting the temperature increase to 1.5°C. Accurate and transparent accounting of greenhouse gas emissions and their abatement within the private sector is fundamental to preventing backsliding on commitments and pledges aligned with the 1.5°C pathway.

There are still some significant hurdles to decarbonization, though, even for the most driven organizations. Reduction of Scope 3 emissions is a critical challenge, as they typically account for the largest and most diverse share of a company's footprint.

Due to a lack of transparency across value chains, these emissions are also the hardest to quantify and tackle. Solving this Scope 3 emissions challenge presents one of the most powerful levers to accelerate decarbonization.

Regulators are beginning to recognize the power and necessity of addressing the global Scope 3 challenge. The European Commission's Corporate Reporting Sustainability Directive (CSRD) requires companies to disclose the percentage of primary data used to calculate Scope 3 emissions. While as recently as October 2022, the International Sustainability Standards Board (ISSB) voted unanimously to require company Scope 3 emissions disclosures in addition to Scopes 1 and 2.

In order to achieve transparency, we need detailed guidelines to consistently calculate and account for emissions at the most granular level, as well as infrastructure to exchange the resulting verified primary data across value chains.

As both a global business membership-based organization and co-convenor of the Greenhouse Gas (GHG) Protocol, WBCSD has long understood these challenges and recognized the critical need for Scope 3 emissions transparency. That's why, in collaboration with 50 companies, standard setters, regulatory bodies, and industry initiatives, we have developed the Pathfinder Framework.

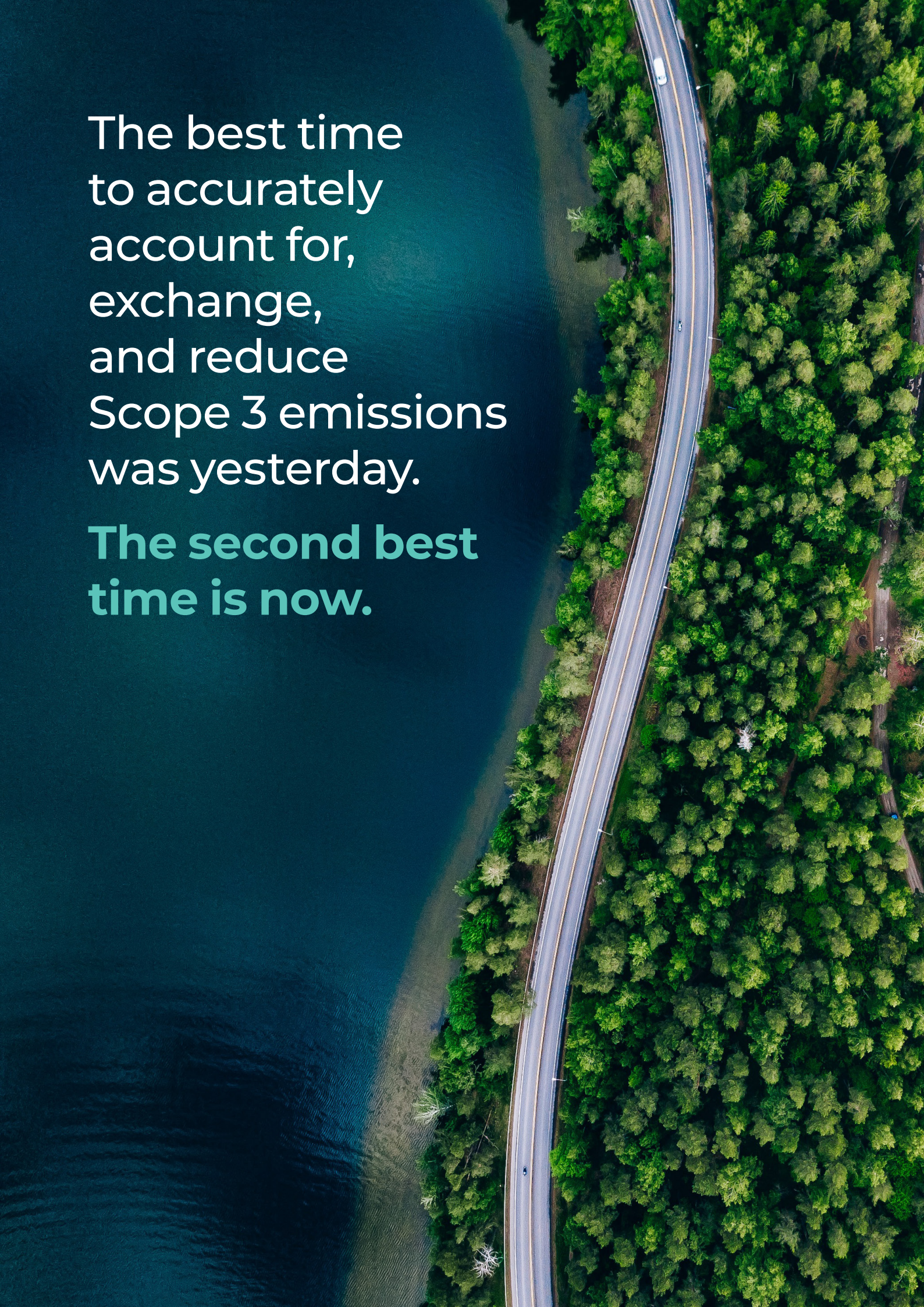
The Pathfinder Framework builds on the long-standing work with the World Resources Institute under the GHG Protocol to take a cross-sectoral approach to help organizations develop and exchange primary data-based product carbon footprints (PCFs) across the value chain. The requirements captured in it seek to further enhance data reliability and consistency across industries and value chains, for instance via the inclusion of a verification and assurance roadmap.

It is important to emphasize that the goal to accelerate decarbonization of value chains cannot be solved by individual actors in isolation. It requires an aligned, coordinated, and open approach, driven jointly by stakeholders across all industries and value chains, including SMEs. Radical collaboration is key.

We commend the large and growing number of companies, organizations, and institutions that have collaborated on and contributed to this Framework. Thank you to those who provided valuable feedback and insights, as well as McKinsey & Company, our knowledge partner, and SINE, our tech collaborator. We urge you to keep these actions up and ensure we all continue to join forces on this essential topic.

The uptake of the Pathfinder Framework represents significant progress in solving the Scope 3 emissions challenge. Now is the time for targeted and bold action: we invite you to start applying the Framework within your organizations and to ask key stakeholders within your value chains to do the same.

Dominic Waughray
Executive Vice President, WBCSD


The best time
to accurately
account for,
exchange,
and reduce
Scope 3 emissions
was yesterday.
The second best
time is now.

1. Introduction

Current efforts to reduce greenhouse gas (GHG) emissions are insufficient to meet the Paris Agreement targets. Accounting for and exchanging reliable and consistent GHG emissions data is key to supercharging decarbonization efforts.

1.1 The challenge

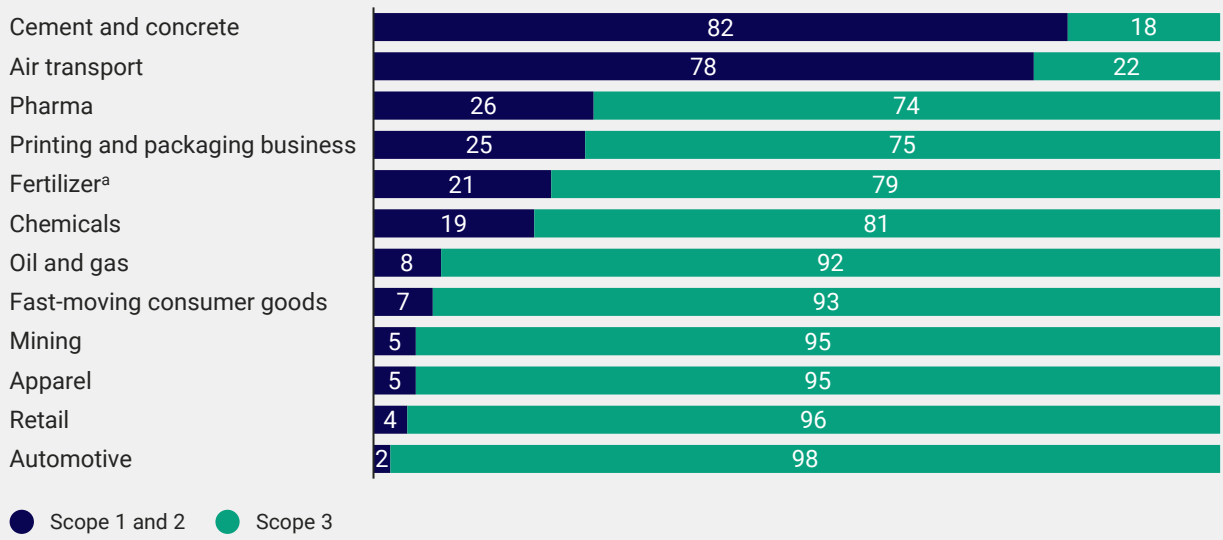
Accurately quantifying and reducing emissions, particularly those in value chains (Scope 3), are key enablers for changing the global warming trajectory and avoiding the worst effects of climate change.

However, while Scope 3 emissions often constitute the lion's share of companies' carbon footprints (Figure 1)[1], organizations are still struggling to adequately understand and address these. When accounting for Scope 3 emissions, companies share a common challenge: a lack of sufficiently granular, accurate, and verified primary product-level data. This is caused by issues with emissions accounting and data sharing as well as by the increasingly complex ecosystem of stakeholders emerging in the emissions accounting space.

Data accounting: Room for interpretation and inconsistency in existing methods and standards

Many companies lack Scope 3 primary data to accurately account for emissions arising within their value chains. Secondary emission factor databases are used to fill this gap, though the average or typical data these provide are often not specific enough to meet the data needs of companies, which range from climate risk assessments to the implementation and tracking of decarbonization strategies and targets. High-quality product life cycle accounting, considered the most accurate approach to account for value chain emissions, is also inhibited by the inconsistent use of approaches to account for product emissions, with existing standards and protocols (such as ISO, GHG Protocol, or Product Environmental Footprint standards) leaving room for interpretation.

Figure 1: **Percent of total Scope 1 to 3 emissions, 2019, based on self-reported CDP data**



a. Includes agricultural chemicals.

Source: McKinsey & Company analysis, drawing on select data from CDP and McKinsey's Catalyst Zero solution

Accounting standards and guidelines that are not fully consistent create challenges for a streamlined, scalable application. This results in inconsistent accounting, which in turn leads to insufficient reporting and exchange of emissions data.

Data access: Complex value chains and lack of interoperability between technology[2] solutions

While value chains often span multiple (international) stakeholders from different industries, most corporate systems are not able to exchange GHG emissions data with other systems (and across company boundaries), resulting in high transaction costs for manual efforts in the form of surveys or spreadsheets. New GHG accounting technology and data exchange platforms, while a step in the right direction, still lack one essential feature: interoperability, i.e., the ability to connect to one another, exchange information, and understand the information exchanged (or "speak the same language"). In practice, this means companies will typically only be able to access each other's data if they use the same technology solution.

Ecosystem alignment: Growing number of stakeholders seeking to tackle the transparency challenge

There has been significant momentum to resolve the challenges around Scope 3 emissions. Regulatory bodies (e.g., US Securities and Exchange Commission, European Commission, International Sustainability Standards Board) and companies are searching for and developing individual approaches, industry-focused associations are addressing their members' most pressing concerns, and the broader ecosystem has also started identifying the role it can play. A lack of integration and harmonization across the ecosystem is a major roadblock to transparency, given that no single company, association, or ecosystem stakeholder can achieve this without the others.

As a result of the above challenges, companies' Scope 3 decarbonization efforts are inhibited. It is impossible to track and reduce Scope 3 emissions at the scale needed without determining and understanding emissions associated with products and services that are transferred from one company to the next in the value chain.

1.2 The solution

An infrastructure developed in close collaboration with stakeholders is needed to enable the consistent calculation and exchange of accurate, primary, and verified product-level emissions data across all value chains and industries.

This infrastructure should be comprised of standardized approaches and common guidelines across both methodology (product-level emissions

accounting) and technology (product-level emissions data exchange):

- On the methodology side, this is to ensure product-level emissions are calculated in a comparable and consistent manner, resulting in accurate, high-quality data.
- On the technology side, there is a need for common data exchange guidelines and technical specifications for interoperable data exchange across global companies and complex value chains.

Furthermore, the creation of a free and open digital network will significantly facilitate data exchange (upstream to downstream, but also downstream to upstream) and strengthen quality and credibility.

1.3 The opportunity

Access to more granular data can unlock a host of use cases that reinforce internal business decision making and support corporate accountability. Transparency can, for example, positively influence the bottom line, mitigate (climate-related) risk, or drive competitive advantages.

This is precisely why the Partnership for Carbon Transparency (PACT) was established. PACT seeks to turn the Scope 3 emissions challenge into an opportunity for companies and organizations by enabling consistent calculation and exchange of primary data of product cradle-to-gate emissions across value chain partners.

Specifically, PACT:

- Creates convergence and harmonization on upstream Scope 3 emissions transparency to ensure an integrated and aligned global ecosystem with close collaboration between all stakeholders
- Establishes the Pathfinder Framework (methodological guidelines) by building on the GHG Protocol and other existing standards to enable consistent product-level emissions accounting and primary data exchange
- Defines the Pathfinder Network (common technology infrastructure) for the secure exchange of product-level emissions data across technology solutions and data exchange platforms, linking global value chains and industries.

Transparency on carbon data can also set the foundations for greater transparency on other environmental factors. If organizations are ready to embark on this journey together, the rewards will be significant—not least for the climate. This work, therefore, has the potential to be a game changer.

2. Overview of general setup

This section gives an overview of the general setup of the Framework with the aim of easing navigation and providing essential context.

2.1 Purpose and application

The Pathfinder Framework was created with the aim of addressing one of the key existing carbon accounting challenges: the exchange of consistent supplier-specific product carbon footprint (PCF) data across the value chain. It seeks to help businesses develop a better understanding of their value chain emissions by encouraging and guiding the exchange of primary carbon footprint data across value chains. The Framework builds on existing frameworks and standards to provide guidance on accounting, verification, and exchange of cradle-to-gate PCFs with the aim of creating more granular, comparable, and consistent emissions data.

The Framework should thus be seen as a supplement to the existing methods and standards referenced in **Section 3.1** and shall be used in conjunction with these. The Framework has been drafted as a blueprint applicable to different industries. It, therefore, constitutes a foundation to build on to meet additional sector-specific needs. As alignment in this context is critical, PACT has been set up to support this process.

While the Framework is designed to be a guidance document and is therefore voluntary in nature, its application will lead to greater emissions data consistency for all stakeholders across industries. To further encourage broad application and facilitate scaling, the Framework has been published openly for everyone to freely access and use.

The Framework should be applied by stakeholders such as:

- Businesses wishing to better understand and exchange the carbon footprint of their products as well as the products they purchase
- Auditors supporting businesses in the above endeavor by verifying carbon footprint data exchanged
- Technology companies creating solutions for the calculation or exchange of such carbon footprints
- Initiatives driving industry-focused approaches to data transparency and developing additional methodological guidance or technological solutions for data exchange in this context
- Policy makers wishing to align their regulations to PCF methodologies validated and implemented industry-wide

2.2 General structure

The Pathfinder Framework is divided into three key parts, which together drive forward the ambition of creating more transparency: emissions accounting, creating integrity, and data exchange (Figure 2). While the first part provides some additional context and outlines fundamental guardrails for suppliers' calculation of PCFs by building on existing standards, part two details key steps in the process toward creating trust in the data and transparency across the value chain. The third part provides details on how the Pathfinder Framework could be integrated as part of an IT infrastructure to facilitate application of the Framework and enable the standardized exchange of emissions data (**Section 6**).

A summary of key takeaways for each section can be found below (Figure 2).

2.3 Approach

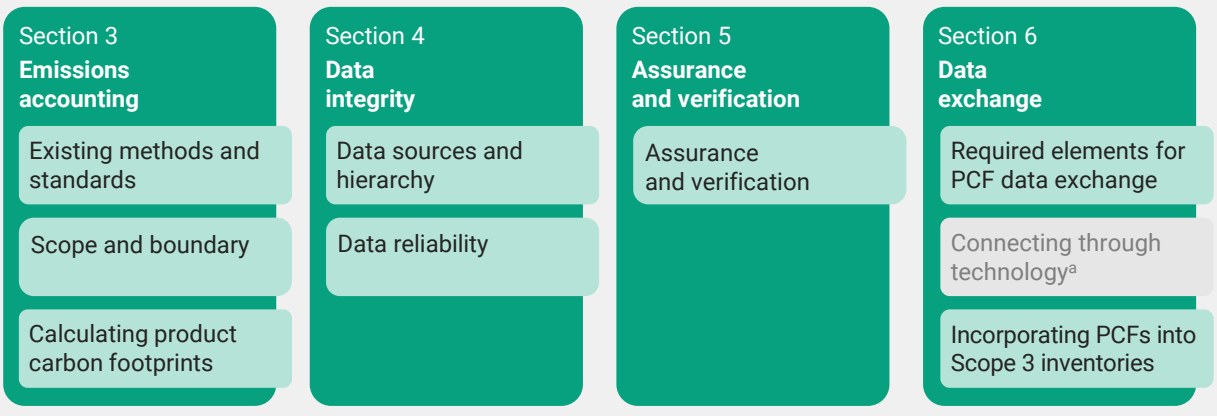
The Pathfinder Framework has been developed following a collaborative approach and is the result of an iterative stakeholder consultation process that also included a pilot testing exercise of the first version of the Framework (published in November 2021).

This updated version of the Pathfinder Framework builds on the first version to incorporate further clarity and additional guidance in the following key areas:

1. Hierarchy for the application of product category rules (PCRs)
2. Quality safeguards for PCRs and secondary data sources
3. More specific PCF accounting guidance on:
   a. Exemption rules
   b. Allocation
   c. Biogenic emissions
4. Data quality indicators
5. Assurance and verification roadmap
6. Incorporation of PCFs into Scope 3 inventories

As the development of consistent rules requires some trial and error, additions or adjustment revisions may be necessary—e.g., as a result of the pilot testing and the practical implementation of the guidance or to remain aligned with the evolving industry needs around emission reduction opportunities and the landscape of carbon accounting and reporting.

Figure 2: Overview of sections within the Pathfinder Framework



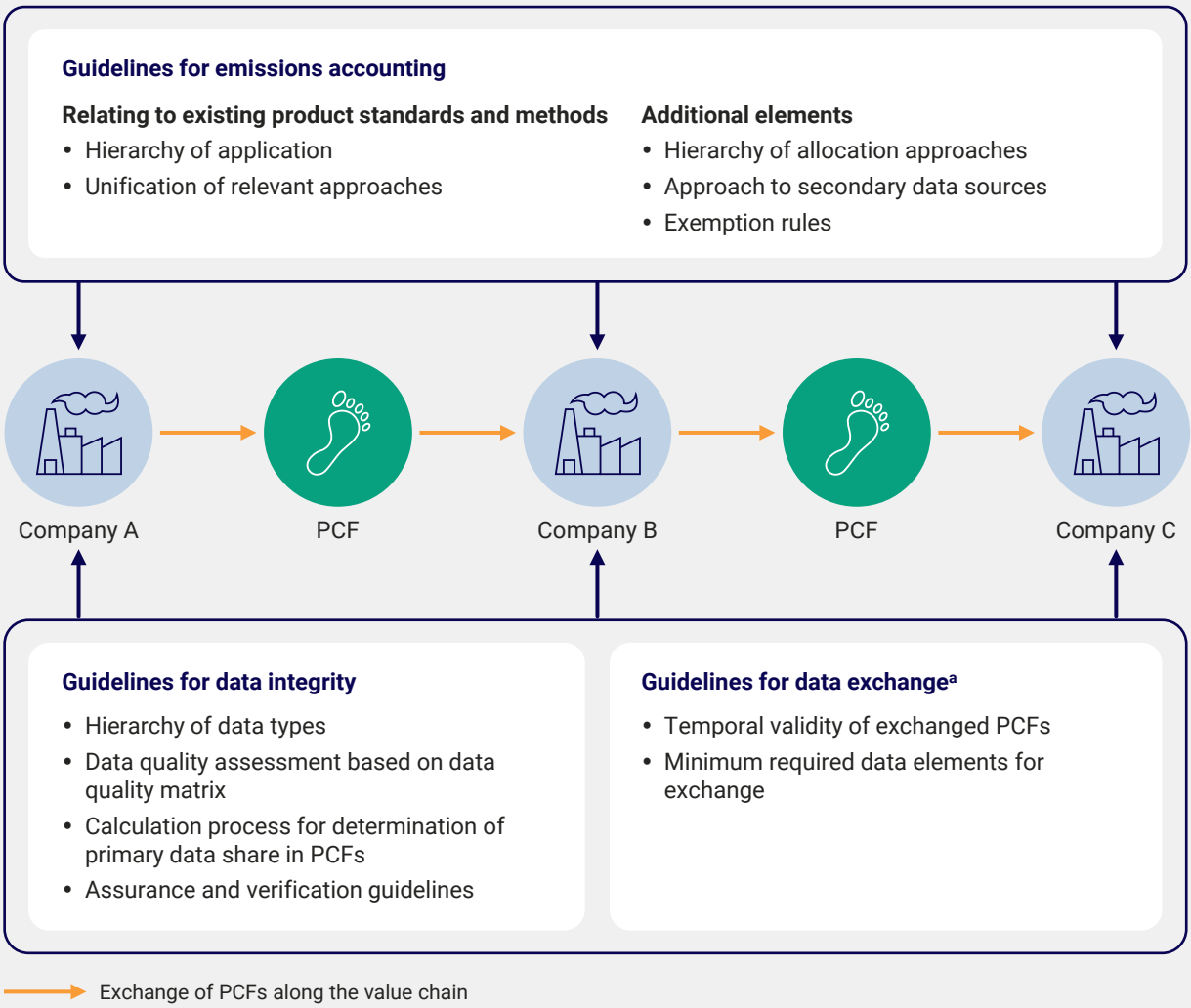
a. Out of the Scope of the Pathfinder Framework.

2.4 Focus

The Framework builds on existing product-level accounting standards and contains guidance for the calculation of cradle-to-gate PCFs to further enhance consistency, data integrity, and comparability. It also covers requirements regarding the exchange of PCF data, in particular focusing on data quality requirements and assessment thereof, verification and assurance of data, and data elements to be exchanged downstream (Figure 3).

This Framework focuses on emissions and removals generated during a product's life cycle and does not address avoided emissions or actions taken to mitigate released emissions. This standard is also not designed to be used for quantifying GHG reductions from offsets or claims of carbon neutrality.

Figure 3: Focus of the Pathfinder Framework



a. Additional technological guidelines and mechanisms for standardized data exchange have been developed in parallel by the Pathfinder Network (e.g., technical data specifications, company onboarding mechanism, or governance structure for the extension of required data elements).

2.5 Terminology

The Pathfinder Framework uses different terms to differentiate between requirements, recommendations, and permissible or allowable options (Table 1).

Additional definitions of frequently used terms throughout the Framework can be found in the glossary (**Appendix A**).

Table 1: Pathfinder Framework terminology

Term	Definition
"Shall"	Indicates which rules need to be followed by companies applying the Pathfinder Framework
"Should"	Indicates which rules are recommendations
"May"	Indicates an option that is permissible or allowable

2.6 Summary of guidelines

Table 2: Summary of guidelines

Emissions accounting

3.1 Existing methods and standards

- The Pathfinder Framework shall be read in conjunction with existing methods and standards listed in Section 3.1 for the assessment of PCFs
- PCRs or sector-specific rules shall be prioritized for the calculation and allocation of PCFs
- PCRs shall only be considered valid if they comply with the Pathfinder Framework's quality safeguards
- If multiple PCRs are applicable, companies shall follow the PCR hierarchy laid out by the Pathfinder Framework
- Where no regulations or product- or sector-specific rules exist, companies shall follow the Pathfinder Framework requirements
- For elements not specifically addressed by the Pathfinder Framework, the PCF calculation shall be compliant with the sector-agnostic standards

3.2 Scope and boundary

- Companies shall account for all GHGs identified within the GHG Protocol
- Their respective 100-year global warming potential (GWP; including carbon feedbacks) shall be derived from the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report publication
- Companies shall report cradle-to-gate PCF, comprising all upstream stages of the product life cycle up to the reporting company's gate (including upstream transportation), excluding downstream emissions from product use and end-of-life
- PCFs shall be exchanged upstream to downstream, providing kg of CO_2e per unit of analysis

3.3 Guidance for PCFs

3.3.1 Accounting for product GHG emissions

- All attributable processes shall be identified
- Companies shall collect relevant activity data and emission factors based on identified attributable processes
- Manufacturing of production equipment, buildings and other capital goods, business travel by personnel, travel to and from work by personnel, and research and development activities should not be included within the boundaries of the PCF, unless materially significant
- Companies shall be able to exclude individual attributable processes representing less than 1% of the total cradle-to-gate PCF
- In aggregate, exclusions shall represent less than 5% of the total cradle-to-gate PCF emissions
- If necessary: allocation of emissions to outputs should follow the Pathfinder Framework allocation hierarchy

Table 2: Summary of guidelines (continued)

Emissions accounting

3.3 Guidance for PCFs

3.3.2 Additional guidance

Biogenic emissions and removals

- Biogenic emissions and removals associated with the following shall be calculated and included as part of the "PCF (incl. biogenic emissions and removals)" metric from 2025 onwards:
  - — Direct land-use change (dLUC)
  - — Land-management-related changes (including land carbon pools and other non-CO2 emissions related to land management)
  - — Other biogenic GHG emissions not covered in dLUC and land management
  - — Biogenic CO_2 withdrawals
- The biogenic carbon content of the product (mass of carbon) shall be calculated and reported separately as part of the data exchange form
- GHG emissions associated with indirect land-use change (iLUC) emissions may be calculated and reported separately as part of the data exchange form. iLUC emissions shall not be included as part of the PCF
- To support transparency, all of the metrics above shall also be reported separately whether they are included in the PCF or not

Transportation emissions

- Upstream and direct transportation emissions within the cradle-to-gate boundary, including storage, shall be calculated and included in the PCF
- Only transportation emissions relating to the fuel—also known as well-to-wheel emissions—and the energy consumed by storage facilities shall be included (i.e., the manufacturing of the vehicles used for the transport of goods shall not be included)

Waste treatment and recycling emissions

- All production emissions shall be allocated to the outputs with economic value, rather than to the waste or recyclable material itself
- Emissions resulting from waste treatment as part of the production process shall be calculated and included in the PCF of the company that manufactured the product and generated the waste
- Emissions from the end-of-life stage of the products shall not be included in the PCF boundary
- Since the Pathfinder Framework's boundary is cradle-to-gate, the "recycled content" method should be used for the allocation of emissions from recycling materials and energy recovery

Table 2: Summary of guidelines (continued)

Creating integrity		
	4.1 Data sources and hierarchy	• Pathfinder Framework definitions shall be used by companies to determine the nature of activity data and emissions • Activity data that is used to calculate PCF shall be company-specific • Secondary emission factors used shall be compliant with Pathfinder Framework safeguards • Companies may use proxy data to bridge minor data gaps
	4.2 Data reliability	• Companies shall either assess the primary data share (PDS) or the data quality of the PCF until 2025; after 2025, both KPIs shall be calculated and exchanged • If calculated, the PDS shall be based on both the nature of the activity data and the emission factors used • If calculated, the data quality ratings (DQRs) shall use the Framework's data quality assessment matrix, excluding any inputs representing less than 5% of the total PCF
Assurance and verification		
	5 Assurance and verification	• Verification of the PCF shall be done by an independent third party following the considerations laid out in the Pathfinder Framework's roadmap
Data exchange		
	6.1 Requirements for PCF data exchange	• Data owners shall exchange their cradle-to-gate PCFs alongside a set of minimum required data elements listed by the Pathfinder Framework downstream in the value chain
	6.2 Connecting through technology	• Companies that have calculated their PCFs should exchange these using the Pathfinder Network
	6.2 Incorporating product-level data into Scope 3 calculations	• Companies should incorporate PCFs into their corporate Scope 3 footprints by multiplying the PCFs provided by suppliers with the number of product units purchased from them

3. Emissions accounting

In order to foster better understanding of emissions, companies shall calculate their cradle-to-gate PCF and exchange this along the value chain.

3.1 Existing methods and standards

The Pathfinder Framework builds on existing methods and standards to provide guidance on which methods to use and when and to provide additional guidance where existing guidelines offer flexibility.

3.1.1 Relationship

The Framework leverages and builds on existing methods and standards for the calculation and allocation of product-level emissions, including:

- Product Life Cycle Accounting and Reporting Standard (GHG Product Standard) and Corporate Value Chain (Scope 3) Standard (GHG Scope 3 Standard) by WBCSD and World Resources Institute under the GHG Protocol
- ISO standards (14044/40, 14067, 14025)
- Product Environmental Footprint (PEF) method and Product Environmental Footprint Category Rules (PEFCRs) by the European Commission (see Box 2)
- PCRs by Environmental Product Declaration (the International EPD System) and other program operators
- Any other product- or sector-specific rules that are compliant with the GHG Protocol rules

The Pathfinder Framework builds on these with the aim of ensuring PCF accounting consistency and comparability. Please refer to **Appendix C** for examples.

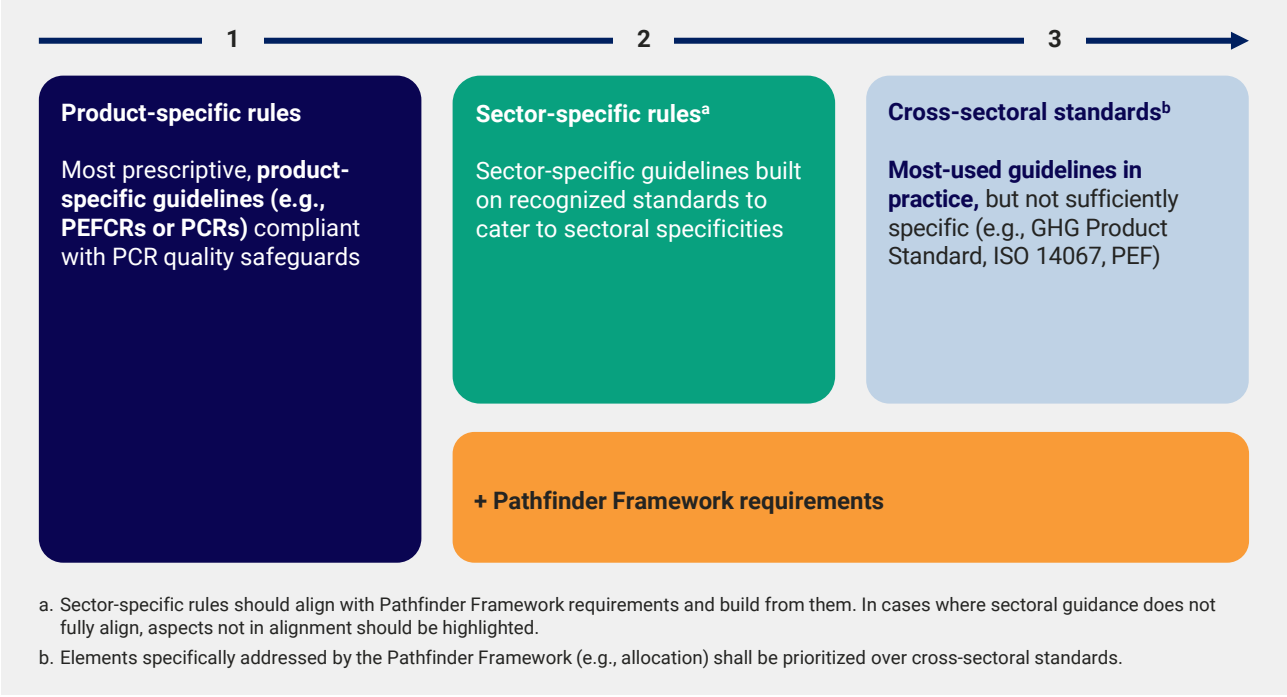
3.1.2 Hierarchy of application

In general, existing methods and standards can be classified into three types:

1. Product-specific rules (e.g., PEFCRs)
2. Sector-specific rules (e.g., Together for Sustainability or PlasticsEurope)
3. Overarching sector-agnostic or cross-sectoral protocols and standards (e.g., GHG Protocol standards, ISO standards, PEF method)

Application of these rules follows the hierarchy shown in Figure 4, whereby three scenarios are envisaged. Please note that product-level regulations applicable to any given product or company (e.g., depending on the sector they operate in) should be prioritized over other existing methods and standards.

Figure 4: Prioritization of methods and standards



a. Sector-specific rules should align with Pathfinder Framework requirements and build from them. In cases where sectoral guidance does not fully align, aspects not in alignment should be highlighted.

b. Elements specifically addressed by the Pathfinder Framework (e.g., allocation) shall be prioritized over cross-sectoral standards.

Product-specific rules exist

According to ISO 14067,[3] a PCR is a "set of specific rules, requirements and guidelines for carbon footprint of a product or partial carbon footprint of a product quantification and communication for one or more product categories."

Where product-specific rules exist, their application should always be prioritized for the cradle-to-gate PCF calculation, as they provide the most detailed guidance in relation to a specific product and hence can contribute to increasing the accuracy and consistency of data exchanged across value chains.[4]

PCRs will most likely overlap with the requirements of **Section 3.3** of this document. In such cases, in line with the hierarchy, the PCRs should be prioritized.

To ensure robustness and reliability, only PCRs meeting the following safeguards shall be considered valid for the purpose of this guidance:

- PCRs shall be developed in accordance with the ISO 14000 series or other cross-sectoral guidance to be considered an eligible PCR.
- PCRs shall be developed through a multistakeholder process and independently peer reviewed.
- PCRs shall be reviewed at least every five years to ensure they are up to date with the latest methodological developments, standards, and market expectations.
- PCRs shall be applicable to the geography where the product is being marketed or produced.

Please note, in some cases, the methodology presented by a PCR may be relevant and appropriate for a given product while their accompanying databases may not be. For example, the methodology presented by a PEFCR may be relevant for a product manufactured in a non-European region, whereas the European data sets may not be the most accurate for that given region. In such cases, companies shall communicate whether a company has followed only the methodological requirements of a PCR but not the accompanying data set.

Sector-specific rules exist

Where no product-specific rules exist, companies shall prioritize the use of sector-specific rules built on cross-sectoral standards (i.e., ISO, GHG Protocol, PEF) for the calculation of PCFs. Please note that the development of new sector-specific guidance should build on and seek alignment with the proposed Pathfinder Framework requirements and further refine them to cater to sectoral specificities (e.g., Together for Sustainability guidance for the chemical sector).[5]

Box 1: Hierarchy of PCRs

While the aim of PCRs is to provide more granular product-specific guidance to facilitate accuracy and consistency, in some instances several PCRs compliant with the quality safeguards may exist for a product or product category (e.g., two PCRs covering the same product but in different regions). The applicability of these different PCRs for companies may vary depending on the purpose behind the development of the PCF. For example, a region-specific PCR may be able to better capture nuances around the manufacturing process of a product in a given region, while a PCR from a global operating association may be better suited to ensuring accounting consistency worldwide. For the purpose of this guidance, companies should thus base their choices on the following hierarchy:

1. If the calculation is to be done for compliance purposes, PCRs' compliance with the regulation should be followed (e.g., PEFCRs).
2. If there is a global sector-specific initiative validating PCRs, these should be prioritized (e.g., TfS, Catena-X).
3. If the calculation is to be done for commercial purposes and no sector-specific guidance on PCRs exists, companies should base their PCR choice on the market in which the product is intended to be manufactured or sold. For instance, if it is intended for the global market, companies should prioritize PCRs from global program operators (e.g., EPD International Program), but if the intended market is a specific country or region, companies should prioritize PCRs applicable to that given geography (e.g., PEFCRs being used for EU market).
4. If the intended market is unclear, companies should prioritize more globally accepted PCRs to favor consistency and broader acceptance.

Only overarching rules exist

Where no product- or sector-specific rules exist, companies shall follow the Pathfinder Framework accounting requirements for more consistency of PCF calculation.

For elements not explicitly addressed by the Pathfinder Framework, the methodology used to calculate PCFs shall be compliant with the cross-sectoral standards (GHG Product Standard, ISO 14067, or PEF).

All of the above standards shall be compliant with ISO 14040 and ISO 14044, which provide foundational requirements and guidelines for life cycle assessments (LCAs) and may be consulted as a reference. In parallel, businesses are encouraged to develop more detailed product or sectoral rules in collaboration with other stakeholders to address any sector- or product-specific needs and drive further consistency in the PCF calculation of any given product.[6]

Box 2: EU PEF method and PEFCRs

Background

While the demand for environmental declarations at the product (and organizational) level has increased in recent years, so far there has not been a single, widely adopted approach, resulting in a lack of comparability and consistency. The European Commission has sought to address this gap through the development of accounting methodologies captured within the PEF and the accompanying PEFCRs.[a]

As defined in the PEFCR Guidance:

- The PEF is based on an LCA method to quantify the relevant environmental impacts of products (goods or services).
- PEFCRs are rules based on product category and life cycle rules that complement general methodological guidance for PEF assessments by providing further specifications at the level of a specific product category.

To date, PEFCRs have been developed for more than 20 different product categories, following a common process defined by the PEF method and, whenever possible, building on existing work such as PCRs.

The objective of these PEFCRs is to help companies identify the most significant environmental impacts and activities throughout the life cycle of a given product. In addition, the use of these common PEFCRs will increase the comparability and consistency of results.

Use

From 2013 to 2019, the European Commission led a pilot phase for 26 product categories. The development phase is now entering a transition stage where the PEFCRs will be implemented on a larger scale, which will determine if and how the PEFCRs will come into effect or be required by law within the European Union.

Link to the Pathfinder Framework

The Pathfinder Framework promotes the application of PEFCRs where available. Notably, PEF methodology and PEFCRs include a set of overarching and product-specific rules, definitions, and proprietary secondary data sources, as well as further life cycle impact categories, which are an addition to the general framework stipulated here. In order to meet the additional requirements from the PEF and PEFCR methodology, companies should refer to the PEF method and respective PEFCR documentation. Any developments by the European Commission in this context will be closely monitored to evaluate and assess the further implementation of PEF and PEFCR requirements into future iterations of this Framework.

a. Equivalent methods have been developed with regard to organizational declarations.

3.2 Scope and boundary

Understanding the Scope and boundary of this Framework is an essential starting point for the calculation of PCFs.

3.2.1 LCA approach

The Pathfinder Framework is based on the attributional LCA approach. This approach seeks to determine the ex post environmental impacts associated with a product's life cycle. GHG emissions are attributed to a specific unit of a product by adding up the emissions of all attributable processes along its life cycle. A PCF represents the potential life cycle impact of a product on the environmental impact category of climate change. This impact category considers that different GHGs have different impacts on climate change, expressed as their GWP with the unit kg CO_2 equivalent (CO_2e).[7]

The basic equation to calculate GHG emissions (CO_2e) for activity data is:

Kg CO_2e	**=**	**Activity data (amount of activity)**	**×**	**Emission factor (kg GHG/ unit of activity)**	**×**	**GWP (kg CO_2e/ kg GHG)**

3.2.2 Focus on GHG emissions

The Pathfinder Framework provides the methodological framework for studying GHG emissions. Companies shall account for the GHGs identified within the GHG Protocol titled "Required Greenhouse Gases in Inventories; Accounting and Reporting Standard Amendment."[8]

The list includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorinated compounds, sulfur hexafluoride (SF_6), nitrogen trifluoride (NF_3), perfluorocarbons (PFCs), fluorinated ethers (HFEs), perfluoropolyethers (e.g., PFPEs), chlorofluorocarbons (CFCs), and hydrochlorofluorocarbons (HCFCs). Following common practice, the global warming impact of these gases can be converted into and expressed as CO_2e. Their respective characterization factors (100-year GWP, including carbon feedbacks) shall be derived from the latest version of the IPCC Assessment Report publication.[9]

3.2.3 Scope and boundary of the Pathfinder Framework

The life cycle of a product is composed of five stages: (1) material acquisition and preprocessing, (2) production, (3) distribution and storage, (4) product use, and (5) end-of-life.

The boundary of the Pathfinder Framework—i.e., the processes and their associated GHG emissions that shall be accounted for and exchanged as part of the PCF by a company—is a cradle-to-gate PCF, covering stages 1 to 3 above.

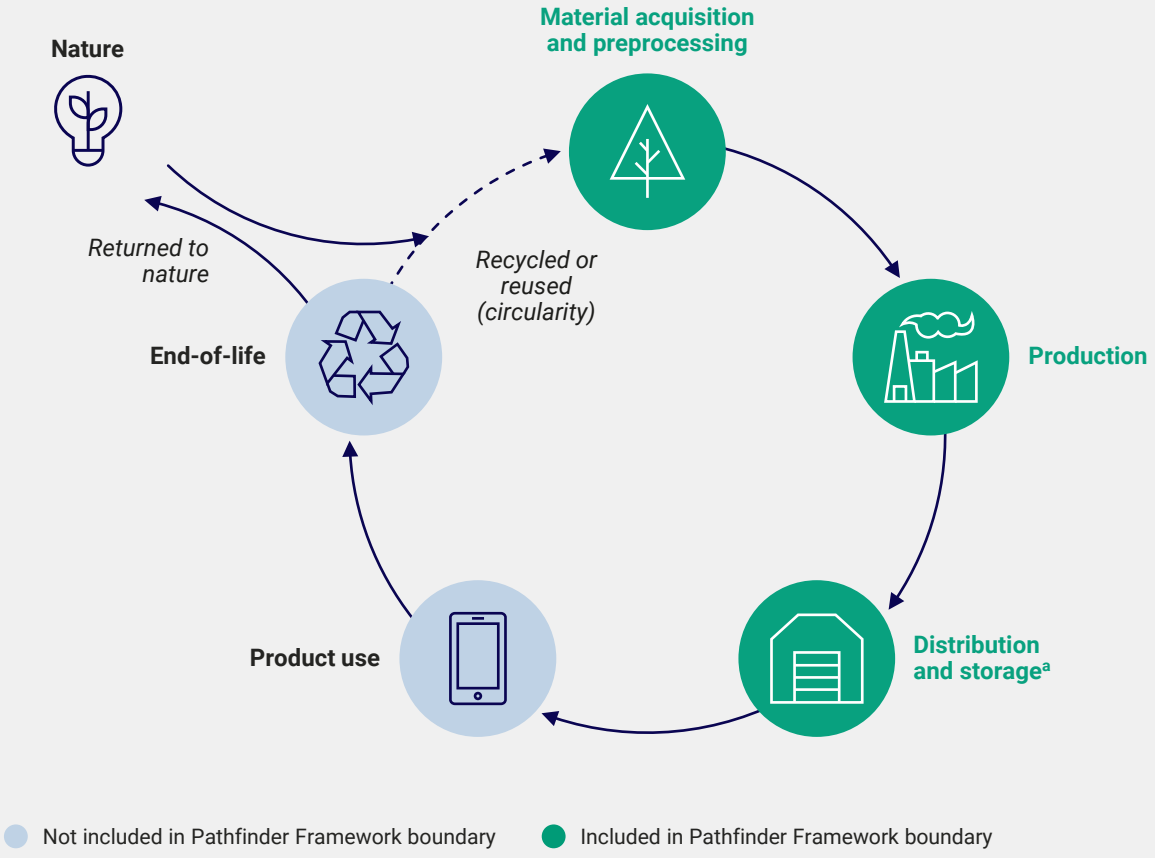
This includes all the attributable upstream and direct emissions[10] of a product, including all upstream transportation activities.[11] The life cycle emissions that shall be accounted for in this cradle-to-gate PCF exclude downstream emissions related to the product use and end-of-life stages.

When accounting for emissions, companies shall further define their cradle-to-gate boundary by organizing the attributable process of their studied product into the defined life cycle stages (Figure 5).

In calculating cradle-to-gate PCFs, which are in turn shared downstream with the next value chain actor, the entire value chain of products and carbon emissions can be linked up, ultimately creating greater transparency for businesses and end consumers alike.

The selected system boundary facilitates the integration of received PCF data from suppliers into own PCF calculation and downstream sharing with respective customers. To increase the transparency of data exchange and to prevent double counting or excluding emissions, the Pathfinder Framework requires companies to report on the attributional processes included in each of the life cycle stages covered by the PCF. The requirements and recommendations for data exchange are explained further in **Section 6** and **Appendix B**.

Figure 5: Life cycle stages included in the boundary of the Pathfinder Framework



a. Contains product storage and shipping processes, including transportation within and between these life cycle stages.

3.2.4 Unit of analysis

The unit of analysis of the product serves as the basis for all data collection and inventory results. Final PCF inventory results shall thus be disclosed as kg of CO_2e per unit of analysis (e.g., GHG emissions per 1 kg or 1 liter of product). Please note that cradle-to-gate PCFs typically use a "declared unit" approach (Box 3).

Box 3: Distinction between functional and declared unit

LCA inventory results are provided in terms of functional units.[a] A functional unit describes the function of a product in question. For example, for a laundry detergent, the functional unit could be defined as "washing 4.5 kg of dry fabric with the recommended dosage with medium-hard water." Understanding the functional unit is essential for comparability between products with the same function, as it provides the reference to which the input (materials and energy) and output (such as products, by-products, waste) are quantified.

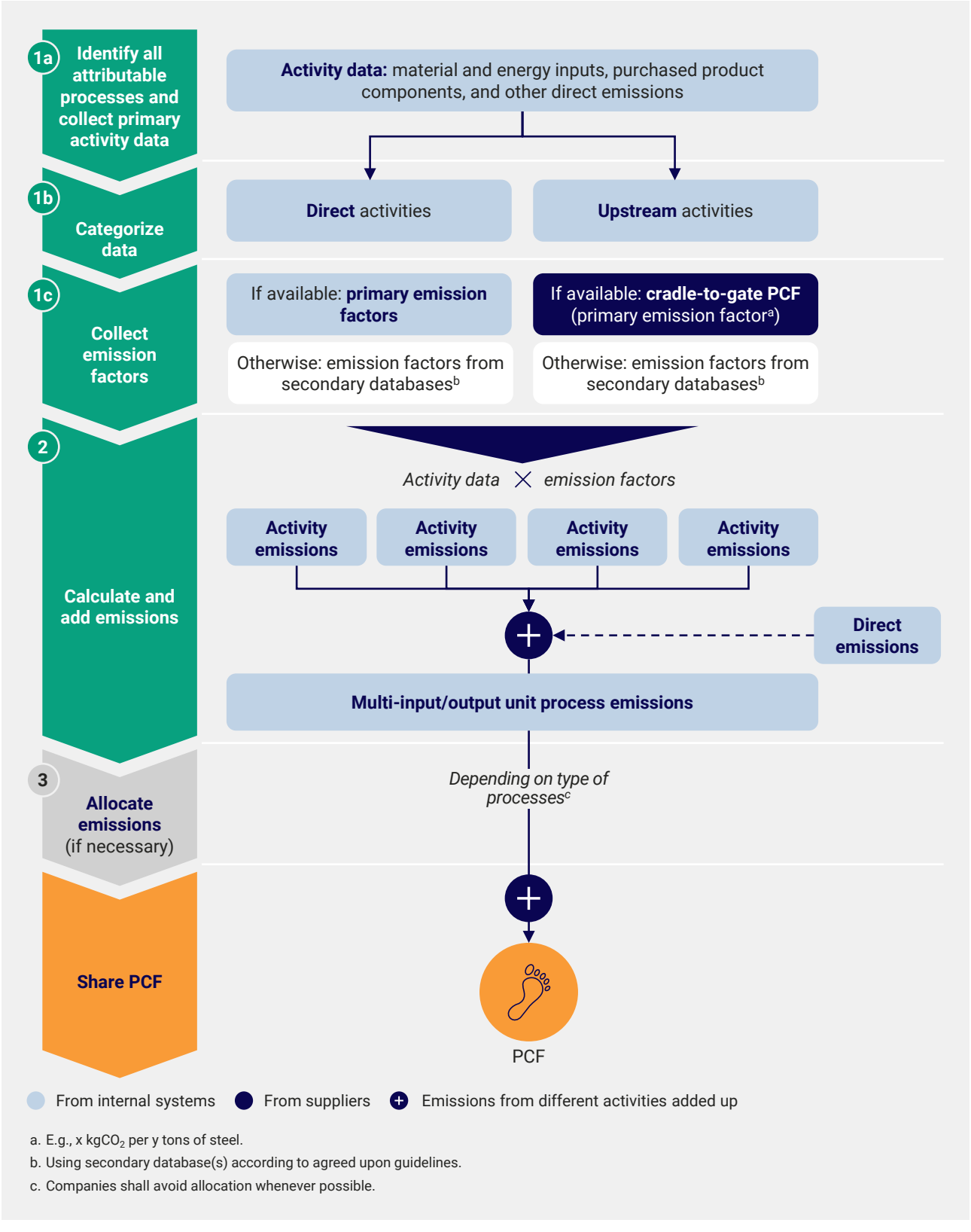
Intermediate products, i.e., products that will still be processed further to create a final product, can, however, have several functions based on their eventual end use. In this case (and where an LCA does not cover the full life cycle), the term declared unit—typically referring to the physical quantity of a product, e.g., "1 liter of liquid laundry detergent with 30 percent water content"—can be used instead.

a. This term is used in ISO 14044 and PEFCRs.

3.3 Guidance for calculating PCFs

This section provides guidance on how to calculate a PCF, which should be used in conjunction with existing methods and standards. Companies calculating their PCF in accordance with a PCR or sector-specific guidance may skip this section.

Figure 6: Overview of steps for PCF calculation



a. E.g., x $kgCO_2$ per y tons of steel.
b. Using secondary database(s) according to agreed upon guidelines.
c. Companies shall avoid allocation whenever possible.

3.3.1 Accounting for product GHG emissions

The following steps are used in the calculation of a PCF: (i) identifying and collecting necessary data, (ii) calculating emissions using relevant emission factors, and (iii) allocating these to specific products or materials (Figure 7).

3.3.1.1 Data identification

First, all the attributable processes linked with the Scope identified in **Section 3.2** (cradle-to-gate) should be identified. This guidance defines "attributable processes" as any processes associated with services, materials, or energy flows that become, make, or carry a product throughout its life cycle.

In alignment with the GHG Product Standard, only those processes that are immediately related to the production of the studied product are part of the assessment. In light of this, the following activities should not be included within the boundaries of the PCF, unless materially significant for the reference product: manufacturing of production equipment, buildings and other capital goods, business travel by personnel, travel to and from work by personnel, and research and development activities. While all of these activities are linked to company operations and should be accounted for within companies' Scope 3 inventories in line with the GHG Scope 3 Standard, they do not tend to be specific to any given product and should therefore not be included in PCFs unless they represent a material percentage of the PCF (e.g., in the case of wind or solar power generation, where the building of the panels and turbines is not negligible on a per kWh basis over the lifetime of the equipment).

In accordance with the cut-off criteria defined in **Section 3.3.1.2** of this guidance, packaging may be excluded or included in the PCF calculation, depending on its contribution to the PCF.

If packaging is included, it should be visible in the description of the product.

To determine multi-input/output unit process emissions, relevant activity data and emission factors based on a company's own processes (direct activities) as well as the relevant material or energy input flows from suppliers upstream (upstream activities) shall be collected.

Inventory data shall be compiled with regard to the following processes:

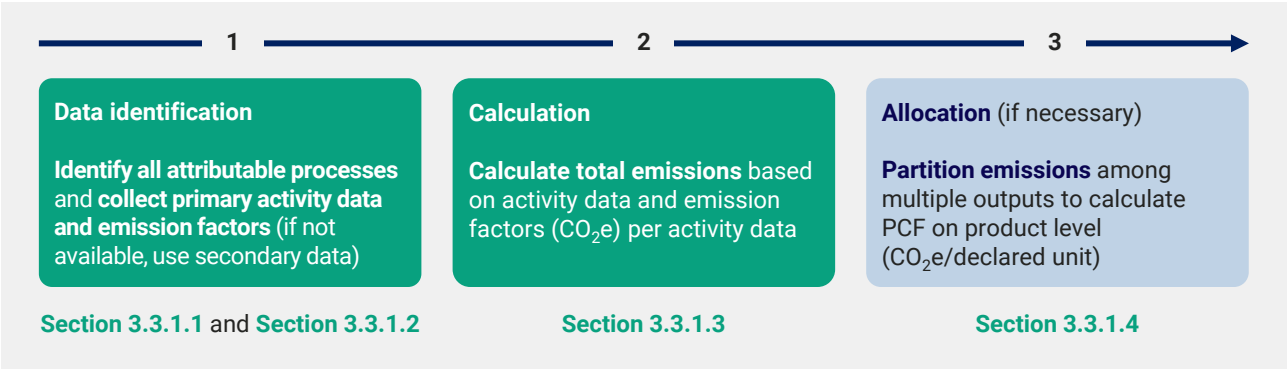
- Material inputs (e.g., 10 tons of steel, 300 kg of aluminum)
- Energy inputs[12] such as purchased electricity, cooling, and heating (e.g., 100 kWh)
- Purchased materials or feedstocks (e.g., chemical component, unit, amount)
- Inbound transport and storage-related inputs (e.g., 10 km transport of 10 kg of chemical components from supplier to manufacturing site in a diesel-fueled truck)
- Production waste and treatment (e.g., 10 kg of cardboard waste sent to landfill)
- Any other direct emissions not included (e.g., CO_2 formed during the production process)

After identification of the data, all data shall be categorized as direct or upstream activities (Figure 6).

3.3.1.2 Exemption rules

Companies should seek to incorporate all attributable cradle-to-gate processes into their PCF. However, there are instances where the lack of data availability or the effort and resources required to calculate certain attributable processes can far outweigh their overall GHG contribution to the PCF. In these cases, companies can exclude the processes if they disclose and justify these, based on their degree of significance to the final PCF.

Figure 7: General steps for the calculation of a PCF



To do so, companies can conduct an initial screening of the product to identify all attributable processes and their contribution to the total PCF to understand whether, in the most conservative case, a process may be deemed insignificant (e.g., via a sensitivity analysis). For this purpose, companies shall only be able to exclude individual attributable processes representing less than 1 percent of the total cradle-to-gate PCF.

In aggregate, the sum of excluded processes (in percentage contribution to total PCF) shall be less than 5 percent of the total estimated cradle-to-gate PCF emissions.[13]

Should no major product modifications occur, companies can employ the results of the initial screening in future iterations.

To justify any exclusions, companies shall provide the percentage of emissions excluded from the PCF as well as a description of the excluded attributable processes and the estimation technique used to determine insignificance.

3.3.1.3 Calculation

GHG emissions arising from a process are determined by multiplying activity data with the relevant emission factor (CO_2e per declared unit). The resulting activity emissions can then be added to direct emissions, if any, to obtain multi-input/output unit process GHG emissions (Figure 6). Emission factors, used to convert a given amount of activity data into GHG emissions, are not to be mistaken for characterization factors, which in the context of emissions assessments refer to the 100-year GWP of the GHGs included in the assessment based on a CO_2e amount (e.g., the GWP of methane is 22 kg CO_2e/kg).

Relevant emission factors can be obtained in two ways:

- **Primary emission factors.** Where such emission factors are available directly from suppliers or internal processes, these shall be used (e.g., blast furnace of gas mix emissions measured directly on site).[14]
- **Secondary emission factors.** Where no such data is available, secondary sources compliant with the safeguards listed in **Section 4.1.3.2** shall be used to find the most suitable emission factors.

Please refer to **Section 4.1.1** for a more detailed definition of the different types of emission factors.

Example: Case study demonstrating a justified exclusion

Consider a process for which no primary or secondary data is available on material input X. The company estimates that even if material X has the highest possible GHG intensity based on a threshold of GHG intensity for proxy data, its impact, based on the total amount present in the product, does not exceed 1 percent of the carbon emissions impact; therefore, the material input is a justified exclusion as long as the total 5 percent threshold including all other exclusions is not surpassed.

3.3.1.4 Allocation

In the context of this guidance, allocation means splitting multi-input/output processes into single output unit processes by using physical, economic, or other criteria to partition the emissions between the product system being studied (also known as the studied product) and one or more other product systems (also known as co-products).[15] When outputs include both co-products and waste (i.e., outputs with no economic value), the emissions shall **only** be allocated to co-products.

While there are methods to avoid it, allocation is unavoidable in many cases. In the absence of a PCR or sector-specific guidance on allocation rules, companies should allocate the emissions in line with the hierarchy presented by recognized cross-sectoral standards (i.e., ISO 14067 and the GHG Protocol) and reflected in Table 3. These standards state that companies are to prioritize physical allocation if an underlying physical relationship can be established and is applicable, or to allocate the inputs and emissions based on economic or other established and justifiable relationships if an underlying physical relationship does not exist or is not applicable (Table 3).

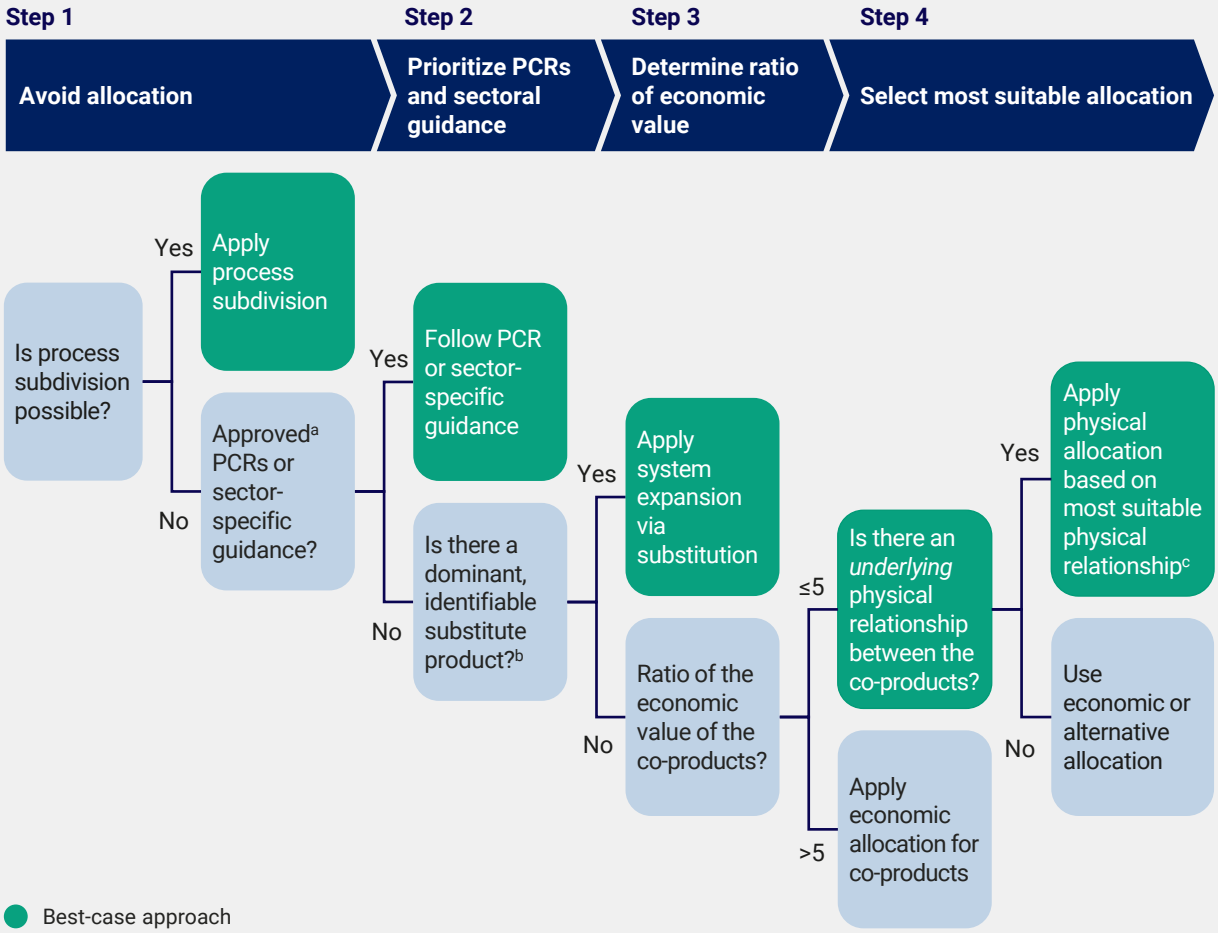
However, the flexibility these standards provide means that in many cases it may not be clear whether a physical relationship is applicable or not (see examples on Figure 9, 10, and 11). Companies may therefore struggle to determine if an economic relationship should be prioritized instead. To promote a consistent decision-making process and minimize the room for interpretation, the Pathfinder Framework has developed a cross-industry allocation hierarchy (Figure 8) that companies should follow to increase the consistency and automatization of PCF calculations.

Table 3: Allocation methods presented by ISO and the GHG Protocol by order of priority

Method	Definition
Physical allocation	Allocating the inputs and emissions of the system based on an underlying physical relationship between the quantity of product and co-product and the quantity of emissions generated
Economic allocation	Allocating the inputs and emissions to the product and co-product(s) based on the market value of each when they exit the common process
Other relationships	Allocating the inputs and emissions to the product and co-products(s) based on established and justifiable relationships other than physical or economic

Source: GHG Protocol

Figure 8: Pathfinder Framework decision-making tree to consistently implement ISO and GHG Protocol allocation rules



a. Sector-specific guidance or PCRs shall be used only if compliant with quality safeguards presented in Section 3.1.2, or if approved and required by sector-specific standards aligned to the Pathfinder Framework.

b. System expansion via substitution should only be used if there is a dominant, identifiable displaced product and production path for the displaced product based on sector consensus.

c. If in doubt, mass allocation should be prioritized, but there are instances where other allocation factors may be more suitable (e.g., liters for liquids, energy content for energy).

Step 1: Avoid allocation

In accordance with the LCA International Standard (ISO 14044) and the GHG Product Standard, allocation shall be avoided whenever possible by using process subdivision, i.e., disaggregating the common processes into subprocesses that separately produce the studied product and co-products. The common process needs to be subdivided only to the point at which the studied product and its function are isolated, not to the point that every co-product has a unique and distinct process.[16]

Step 2: Prioritize PCRs and sector-specific guidance

When avoiding allocation is not possible, allocation methods in line with published and accepted sector-specific guidance or PCR fulfilling the quality requirements listed in **Section 3.1.2** shall be prioritized. When more than one PCR exists for a product or product category, priority shall be determined in line with the hierarchy specified in **Section 3.1.2**.

Should no PCR or sector-specific guidelines exist, companies shall apply system expansion via direct substitution only when companies have "direct knowledge of the function and eventual use of the co-product."[17] This entails defining a dominant, identifiable displaced product and production path for the displaced product for which sector consensus exists.

Step 3: Determine the ratio of economic value

When allocation cannot be avoided and there are no established product- or sector-specific allocation rules, companies shall calculate the ratio of the economic value of the co-products. To calculate the ratio, the highest value product is placed in the numerator, regardless of whether it is the reference product or not. This ratio is employed in the next step to determine the most suitable allocation approach.

The underlying logic is that, in the case of high discrepancy in the market value of product coming from a common process (i.e., economic value ratio higher than five), the product(s) with significantly higher economic value can be considered the "driver(s) of the process." In other words, the production would not take place in the absence of the product with the highest economic value.

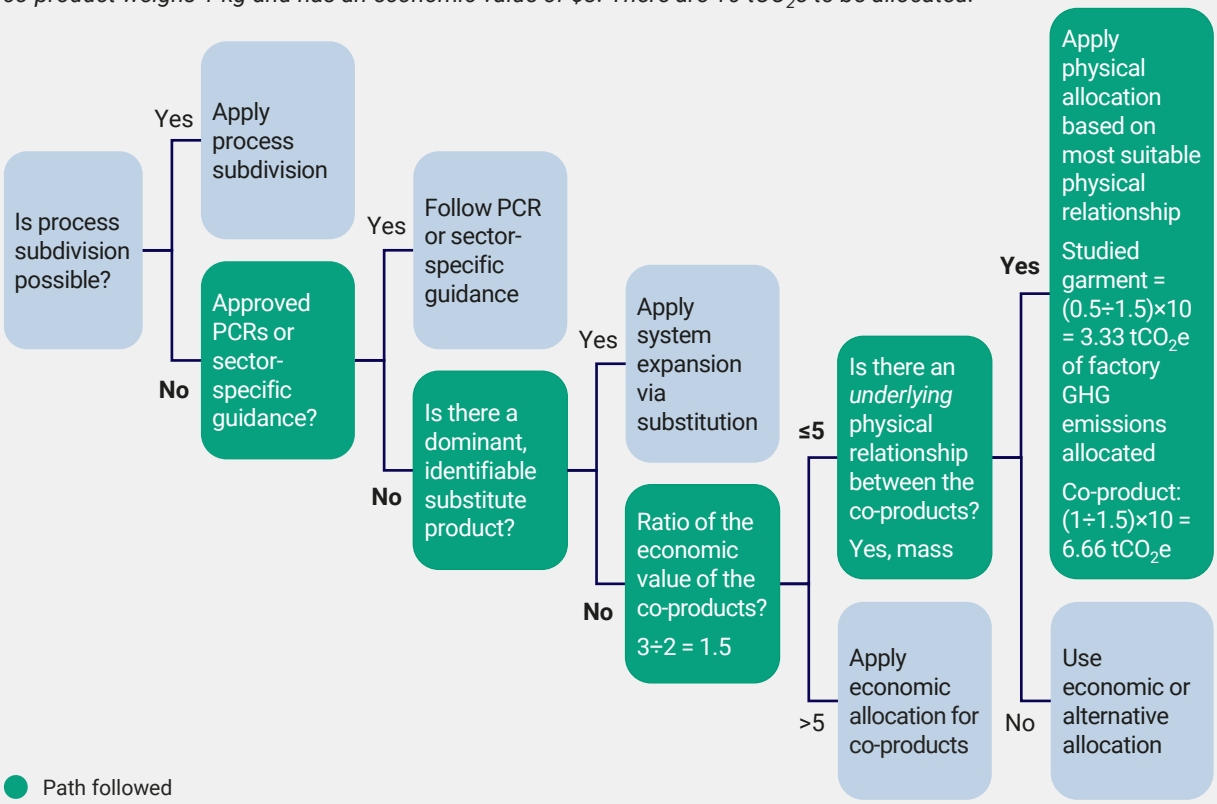
The economic value of products should be calculated based on stable market prices. In case of high year-on-year price fluctuation (i.e., over 100 percent), companies should use the average market price of products over ideally the last five years, and, if not possible, over the last three years in order to reduce the economic value fluctuations. If market prices are not available, other financial metrics (e.g., costs) may be used as long as they are justified and transparently communicated.

Step 4: Select the most suitable allocation method

If the calculated economic value ratio is equal to or lower than five,[18] companies should apply physical allocation between the studied product and the co-product(s). That is, allocating the inputs and emissions of the system based on the most relevant underlying physical relationship between the product and co-product. For this, the physical property used as the allocation factor should most accurately reflect the underlying physical relationship between the studied product and co-product. Should no underlying physical relationship exist, companies shall allocate emissions based on the economic value and amount of each co-product that is produced or based on alternative factors established by the sector, company, academia, or other sources of conventions and norms (Figure 9).

Figure 9: Example of physical allocation based on mass

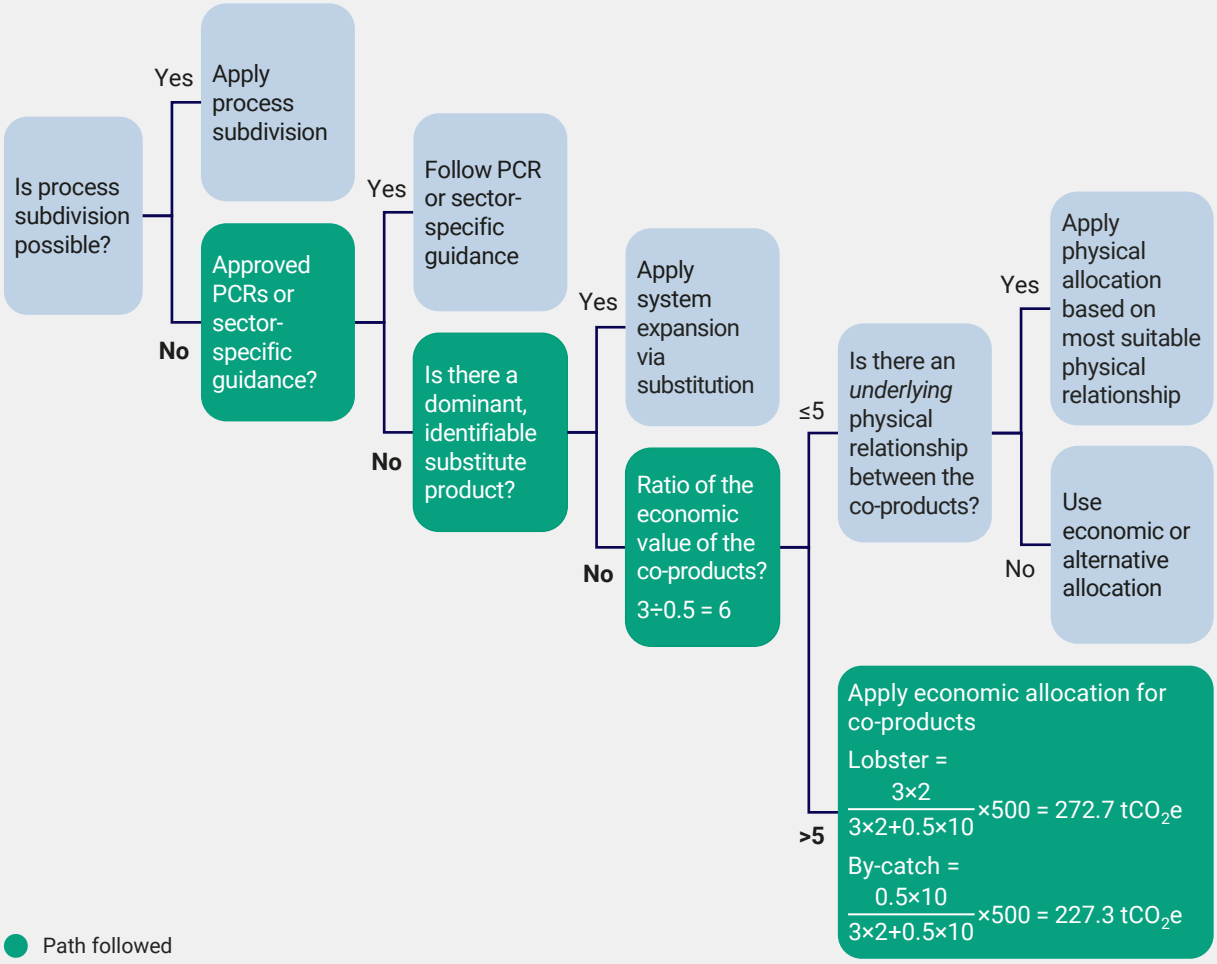
Case study: *Factory produces two different clothing garments on equal measure but is unable to perform process subdivision. No PCRs exist. Our studied garment weighs 0.5 kg and has an economic value of $2, while the co-product weighs 1 kg and has an economic value of $3. There are 10 tCO_2e to be allocated.*



When the calculated economic value ratio is higher than five, companies shall directly apply an economic allocation between the studied product and the co-product(s). That is, allocating the inputs and emissions to the product and co-product(s) based on the economic value and the amount of each that is produced when they exit the common process (see Step 3 for more detailed guidance on how to calculate the economic value) (Figure 10).

Figure 10: Example of economic allocation

Case study: *Lobster fishing company has caught significant amounts of fish (by-catch) alongside lobsters during the studied year. When seeking to allocate 500 tCO_2e emissions associated with the yearly activity, they account for 10 t of by-catch and 2 t of lobster (our studied product). A lobster's economic value is $3/t, compared to $0.5/t for the by-catch.*



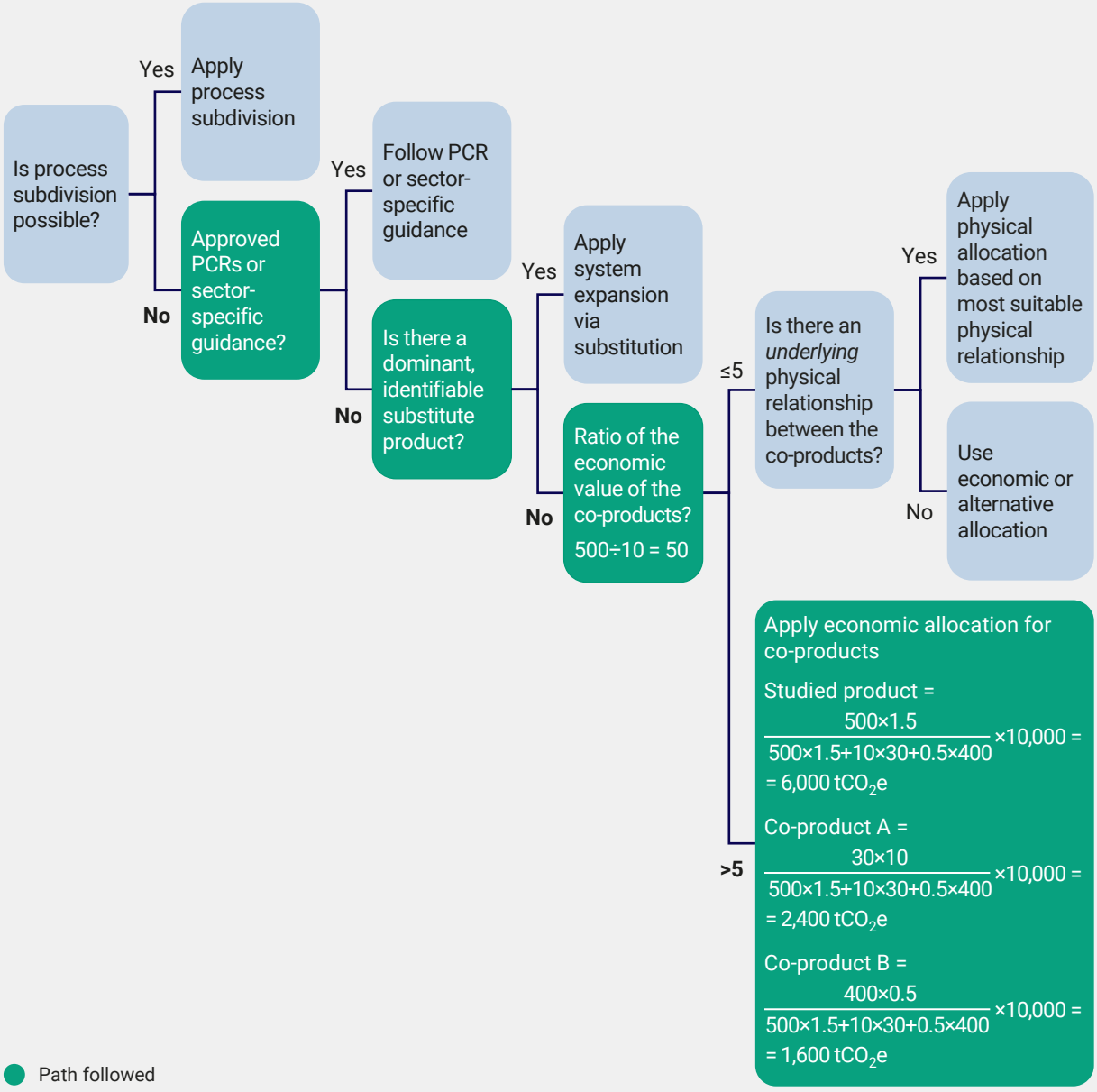
Allocation with more than one co-product

In the case of more than one co-product, the economic value ratio shall be calculated based on the ratio between the highest valued and the lower valued co-product, regardless of whether that includes the studied product. This approach aims to ensure consistency in the allocation followed regardless of which product becomes the studied product. Similar to above, if the difference between the highest and lowest valued co-products is lower than five, emissions shall be allocated following physical allocation if possible, and economic or alternative allocations if not possible. See Figure 11 below for a more visual representation of this process.

Regardless of which allocation methods are used to avoid or perform allocation, companies shall disclose and justify these, including why the methods and factors most accurately reflect the studied product's or co-product's contribution to the common process' total emissions.

Figure 11: Example of allocation with more than one co-product

Case study: *Mining company extracts and sells three products from a single mine. Process subdivision is not possible, and no PCRs are available. Studied product's economic value is $500 M/t and has a mass of 1.5t; it has two co-products with values of $10 M/t and 30 t (co-product A) and $400 M/t and 0.5 t (co-product B), respectively. There are 10,000 tCO_2e to be allocated.*



3.3.2 Additional guidance

3.3.2.1 Accounting for biogenic emissions and removals

This section provides guidance and requirements on how to account for and report biogenic emissions and removals associated with land-based products as part of the PCF.

The calculation of all the below metrics shall be done in accordance with internationally recognized methodologies. The methodologies and resources used to calculate and report on biogenic emissions and removals shall be provided and documented as part of the PCF data exchange form.

Please note, 2025 has been set as the first mandatory year to report biogenic emissions and removals to give companies enough time to familiarize themselves with the content. However, companies who consider biogenic emissions and removals to be relevant for their products should include these in the calculations and data exchanged.

A. Accounting for direct land-use change (dLUC) emissions

GHG emissions associated with dLUC (allocated to the reference product) shall be calculated and included as part of the PCF and shall also be reported separately as part of the data exchange form. In the case of no value chain and/or data traceability to account for dLUC, companies shall account for statistical land-use change (sLUC) emissions as a proxy for dLUC and follow the same reporting requirements.

B. Accounting for land management emissions and removals

GHG emissions and removals associated with land-management-related changes should be calculated and included in the PCF and shall also be reported separately as part of the data exchange form. Land management emissions and removals include all land carbon pools—i.e., soil organic carbon, dead organic matter, and biomass carbon stocks—as well as other non-CO_2 emissions related to land management. The following list provides an overview of non-CO_2 sources related to land management GHG emissions:

- CH_4 and N_2O emissions from livestock, including emissions from enteric CH_4 fermentation and manure management
- Non-biogenic CO_2 and N_2O emissions from agricultural soils and inputs, including fertilizers, pesticides, and herbicides
- CH_4 and N_2O emissions from biomass burning and fires
- CH_4 emissions from rice production
- Other CH_4, N_2O, non-biogenic CO_2, HFCs, and PFCs emissions, including emissions from on-site fuel and energy consumption, fuel combustion, air conditioning and refrigerant use, on-site waste or wastewater management, and indirect emissions from purchased energy.

If land management emissions and removals are not assessed, this decision shall be justified in the PCF data exchange form.

Box 4: GHG Protocol Land Sector and Removals Guidance

To enable better and more consistent quantification of emissions related to land use, land-use change, and biogenic products in the value chain, the GHG Protocol is developing the GHG Protocol Land Sector and Removals Guidance. The Guidance provides corporate-level guidelines and requirements on accounting for and reporting biogenic emissions and removals across the value chain. While the guidance focuses on corporate-level accounting, it has clear implications and overlaps with biogenic emissions within product-level accounting (see **Section 6.3**). Please note that this section of the Pathfinder Framework will be revisited once the Land Sector and Removal Guidance is published to ensure companies are able to consistently report biogenic emissions and removals at both the corporate and product level.

C. Accounting for other biogenic emissions

All other biogenic GHG emissions associated with product manufacturing and transport that are not included above should be calculated and included in the PCF and shall also be reported separately as part of the data exchange form. If such biogenic emissions are not included as part of the PCF, this decision shall be justified in the PCF data exchange form.

D. Accounting for the biogenic carbon content

The biogenic carbon content in the product (mass of carbon) shall be calculated and reported separately as part of the data exchange form.

E. Accounting for biogenic CO_2 withdrawals

Biogenic carbon content in the product converted to CO_2e shall be calculated and reported separately as part of the data exchange form.[19]

F. Accounting for indirect land-use change (iLUC)

GHG emissions associated with iLUC emissions may be calculated and reported separately as part of the data exchange form. iLUC emissions shall not be included as part of the PCF.

The following table summarizes the requirements specified above, detailing which elements shall be reported within the "PCF (incl. biogenic emissions and removals)" metric and which elements shall not be included but may be reported separately. To support transparency, all of the metrics shall also be reported separately, regardless of whether they are included in the PCF or not (Table 4).

Table 4: Summary of biogenic emissions and removals data attributes to be included in the PCF data exchange form

	Unit	Included in PCF (incl. biogenic emissions and removals)[a]	Reported separately	Mandatory
dLUC emissions	$KgCO_2e$	Yes	Yes	Yes, from 2025
Land management GHG emissions or removals (incl. non-CO_2 sources)	$KgCO_2e$	Yes	Yes	Yes, from 2025[b]
Other biogenic emissions (excl. land-use change and land management)	$KgCO_2e$	Yes	Yes	Yes, from 2025[c]
Biogenic carbon content	Kg	No	Yes	Yes, from 2025
Biogenic CO_2 withdrawal	$KgCO_2e$	Yes	Yes	Yes, from 2025
iLUC emissions	$KgCO_2e$	No	Yes	No

a. For the full list of data attributes to be calculated and exchanged as part of the data exchange form, please refer to Appendix B.
b. If changes in land carbon pools are not assessed, this decision shall be justified in the PCF data exchange form.
c. If such biogenic emissions are not included in the PCF, this decision shall be justified in the PCF data exchange form.

3.3.2.2 Accounting for transportation and distribution emissions

Transportation and storage of products can take place as follows:

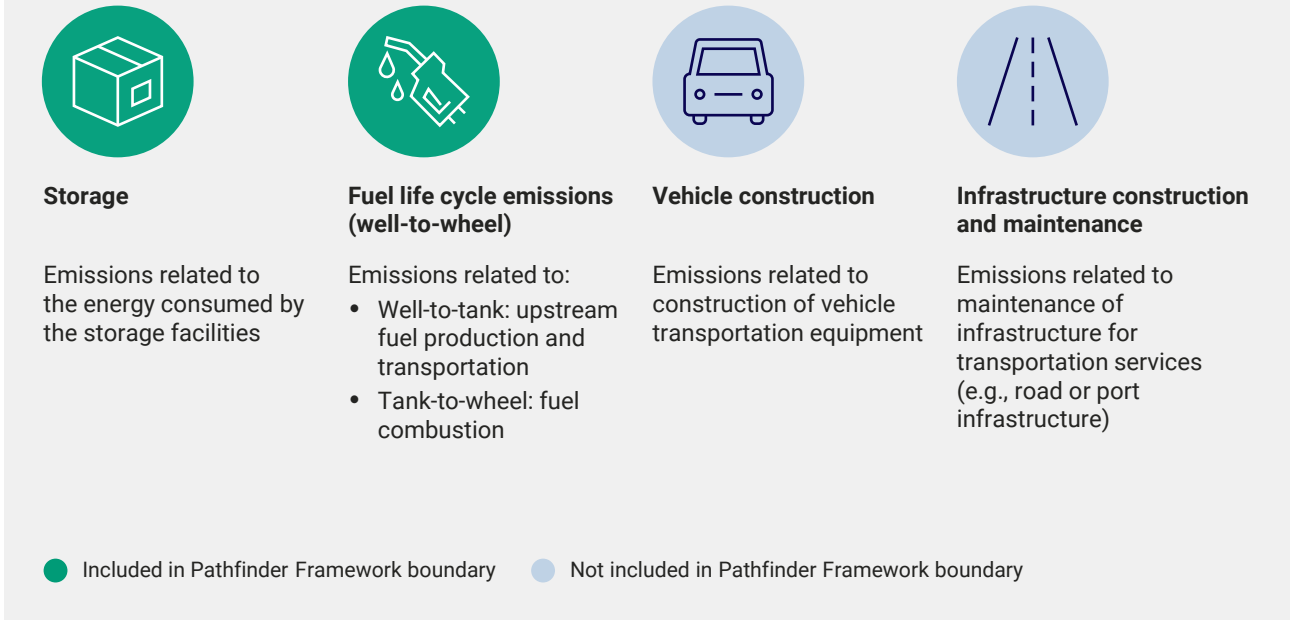
- Internally and as part of direct activities in vehicles and sites owned by the company undergoing the assessment, e.g., the transportation of intermediate or final products between different sections within the factory or agricultural mobile emissions such as tractors
- Externally between different tiers in the supply chain in vehicles or facilities owned by third-party companies, e.g., the transportation of raw materials to the company site (upstream) or transportation of the final product to consumers (downstream).

All significant upstream and direct transportation emissions within the cradle-to-gate boundary—i.e., transportation and storage emissions related to a company's direct activities and distribution activities between tiers in the supply chain relating to the PCF—shall be accounted for. For all these activities, only emissions pertaining to the fuel life cycle (well-to-wheel emissions) and the energy consumed by storage facilities shall be included (Figure 12).[20]

To this end, the following data and information should be collected and used:

- Fuel usage
- Mode of transportation, such as road or rail
- Mass of transported product in tons (expressed per unit of analysis)
- Distance covered
- Load specifications (if available)
- Energy consumed by storage facility
- Area contracted to store reference product (in case of third-party storage).

Figure 12: Transportation emissions accounted for within the transportation boundary of the Pathfinder Framework



A. Accounting for storage emissions

If material, calculation of storage emissions will be done by multiplying the percentage of the total area that is covered by the reference product with the total energy consumption of the storage facility, which in turn will be multiplied by the emission factors associated with the different energy sources used on site (see the formula below).

Should no information be available on the total energy usage of the facilities, companies may use industry benchmarks based on the site's total floor area.

$$\text{GHG emissions}_{\text{storage}} = \frac{\text{Area}_{\text{product}}}{\text{Area}_{\text{storage site}}} \times \text{Energy consumption}_{\text{site}} \times \text{Emission factor}_{\text{energy type}}$$

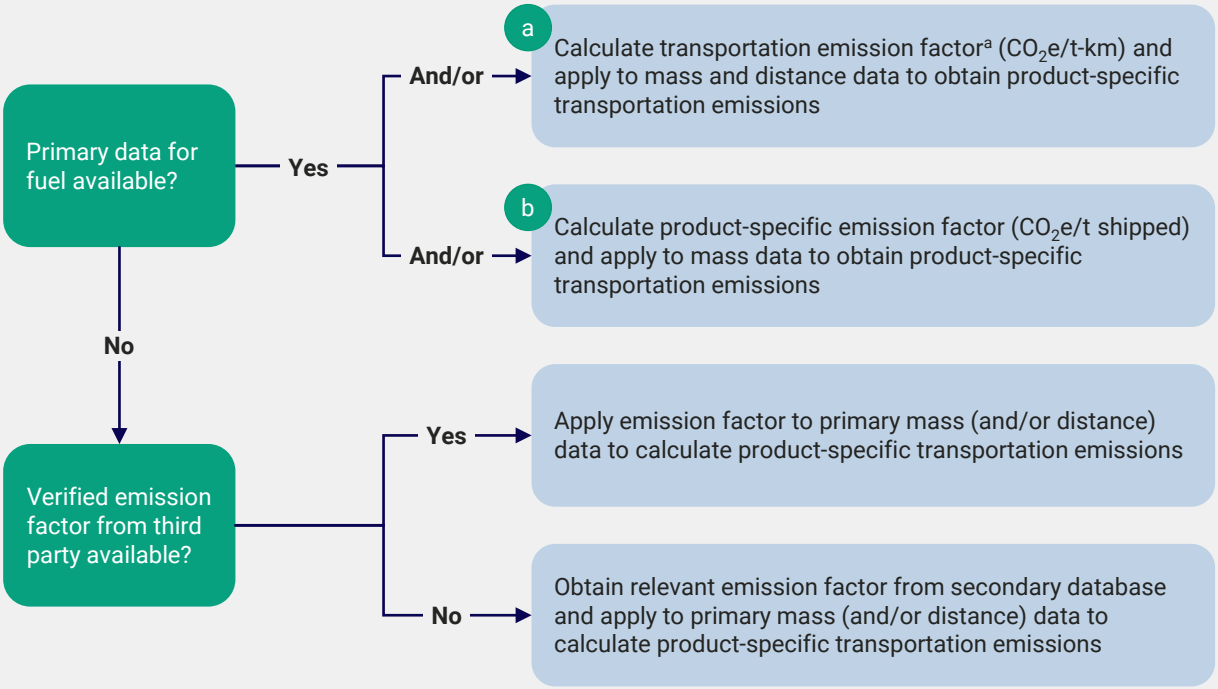
B. Accounting for transportation emissions

Calculation of product transportation emissions depends on the availability of data on fuel consumption, mass, distance, and load factor (Figure 13).

The prevalent unit of measure used for calculation and exchange of logistics emissions is ton-km, reflecting the mass of the shipment (in tons) and distance transported.

For further guidance, please refer to the Global Logistics Emissions Council (GLEC) Framework and GHG Protocol standards.

Figure 13: Steps for calculating product transportation emissions based on data availability



a. Emission factors are always per transportation mode and type.

3.3.2.3 Accounting for waste treatment and recycling emissions within the cradle-to-gate boundary

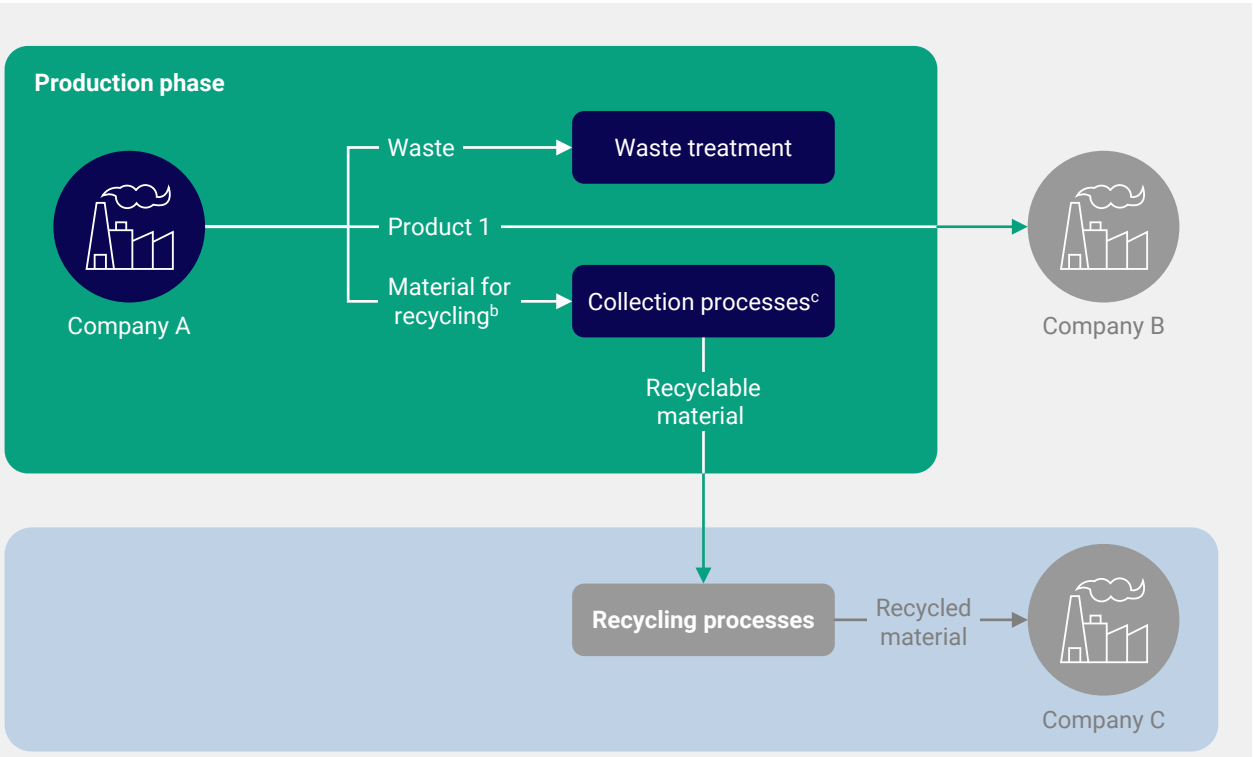
In alignment with the GHG Product Standard and the International EPD System, responsibility for waste processing is placed on the company that generates the waste during the production phase until the waste is returned to nature (e.g., incinerated) or has reached its end-of-waste state,[21] e.g., is used in another product's life cycle (recycled).

For each product that generates waste, companies need to determine whether such waste will be recycled or discarded as waste. If it is discarded, any emissions arising from the treatment of waste during the production process shall be included in the total PCF.

Since the Pathfinder Framework's boundary does not include the end-of-life stage (see **Section 3.2**), the "recycled content" or cut-off method of the GHG Product Standard[22] should be used for the allocation of emissions from recycling materials. The recycled content method stipulates that companies using recycled material as an input in their production shall account for the emissions from the recycling stage, similar to when they account for the emissions of the material they purchase (Figure 14). The cut-off approach should also be used when accounting for waste treatment with energy recovery. Companies following a different approach shall communicate this when exchanging the data to ensure all waste-related emissions are accounted for and allocated among the different value chain players.

The cut-off method is preferable as it is applicable to most use cases, including complex supply chains or where the product system includes many recycled material inputs and outputs.[23] Additionally, it is recommended for Scope 3 inventories due to its ease of implementation and consistency with inventory accounting methods and secondary emission factors.[24] Finally, the method also prevents emissions from being double counted if a company both purchases and sells recycled products. Regardless of the approach followed, avoided emissions shall not be included in the final PCF.

Figure 14: Allocation of waste treatment and recycling emissions



a. Waste and recyclable material streams are not burdened by production impacts (exit burden-free). Direct emissions should be only allocated to main products and by-products (Product 1).

b. Material that would otherwise have been considered waste.

c. Can include preprocessing.

Emissions from the treatment of waste generated during production shall be allocated to the studied product or co-products following the hierarchy stipulated in **Section 3.3.1.4**. Since waste is considered an output without economic value, no production emissions are allocated to the actual waste generated during production.

The applicable approach to calculating emissions depends on where the waste is treated.

A. Waste treated by the company that generates it

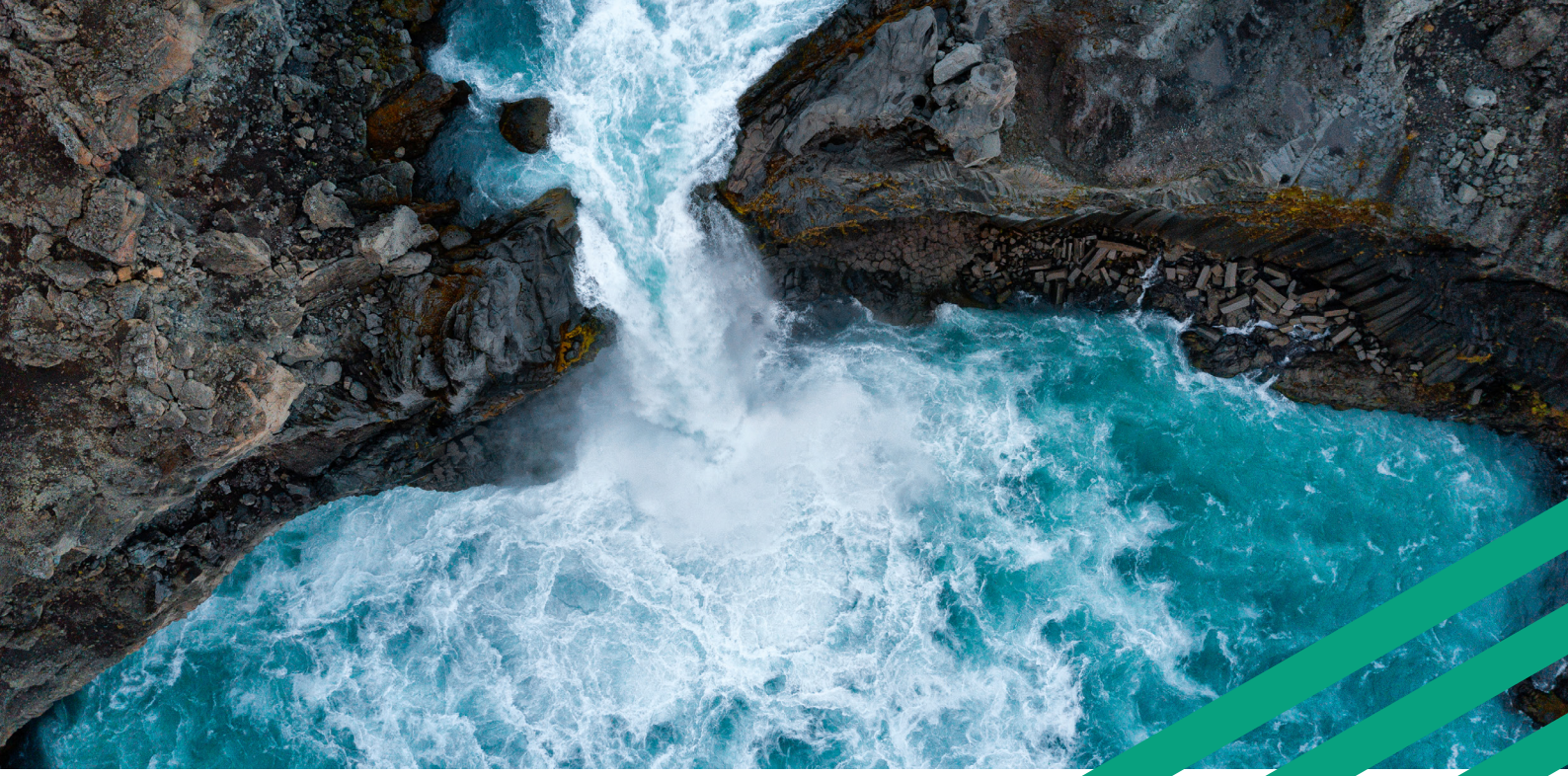
Emissions shall be calculated using primary activity data regarding the type of waste, its composition, and type of waste treatment activity. Depending on the type of waste treatment (e.g., landfill or incineration), companies may use waste treatment emission factors calculated based on internal primary data. Internal emission factors should be verified by an independent auditor prior to being used. If no primary emission factors are available, emission factors derived from accepted secondary sources can be employed (**Section 4.1.3.2**).

B. Generated waste sent to a third party for waste treatment

Waste treatment facilities should calculate their waste treatment emissions (Scope 1 and 2), develop emission factors, and verify and communicate these to either the company that generated the waste in instances where the waste is not recycled or the company making used of the recycled material in instances where it is.[25] This approach is consistent with the cut-off method detailed above.

Alternatively, the waste treatment facility may share primary data via the supplier-specific method.[26] This involves collecting certified emissions data from waste treatment companies and allocating the corresponding emissions to the products in question (if required) using the same allocation framework used to allocate direct emissions across the products (**Section 3.3.1.4**).

If companies do not have access to primary data from waste treatment facilities, they shall estimate waste treatment emissions using primary activity data on the waste type and composition and secondary emission factors according to the type of waste treatment and disposal (landfill, incineration, or recycling). The criteria used to determine valid secondary emission factors in **Section 4.1.3.2** shall be referred to in this context.



4. Data integrity

One of the core aims of PACT is to increase the share of quality primary data used to calculate PCFs.

4.1 Data sources and hierarchy

This section provides definitions and overarching guidance for the prioritization of data sources and the use of secondary data when primary data is not available.[27]

4.1.1 Defining the data hierarchy

For a PCF calculation to take place, two types of data are required: activity data and emission factors. Both of these can be derived from different sources, which this guidance categorizes into primary, secondary, and proxy data. Table 5 presents the definitions that shall be used by companies to determine the nature of activity data and emission factors.

One of the core aims of the Pathfinder Framework is to enable the use of high-quality data for PCF calculations. In line with this ambition, companies are encouraged to directly measure GHG emissions or calculate GHG emissions based on both primary activity data and emission factors ("best case"). However, the use of secondary or proxy data is practically unavoidable, especially in the case of missing data or when conducting an initial PCF screening.[28] Table 6 shows a hierarchy for data sources that can be used for energy (electricity, heating, cooling) and material inputs.

4.1.2 Selecting primary data

Companies shall prioritize the collection of primary activity and emissions data to calculate their PCFs (e.g., by requesting that suppliers report PCFs following Pathfinder Framework requirements). In some cases, further polishing and aggregating the data may be required to refine the emissions estimate. Algorithms may be used to fill in the missing data, or data aggregation may be required to dampen the effect of revisions, turnarounds, or other atypical production conditions.

Table 5: Data type definitions

Data type	Activity data	Emission factor	Example
Primary	Site- or supplier-specific data directly measured, collected, or calculated (e.g., engineering estimates)	Calculated based on company-owned primary activity data or provided by a supplier for a process under their control	Direct GHG combustion emissions or well-characterized emission factors based on stoichiometry
Secondary	Data not directly collected, measured, or calculated based on specific company production data	Emission factors derived from secondary sources	Default factors, regional industry averages, literature studies, government statistics, financial data, and environmentally extended input-output databases (EEIO)
Proxy	Extrapolated, scaled-up, or customized data. Data from similar processes used as a stand-in for a specific process, e.g., based on geography, outdated data		Customizing amount of material consumed by a process from another product's life cycle Using electricity grid emission factors from one region for another region with similar generation mix

Table 6: Data hierarchy for energy and material inputs

	Activity data source		Emissions factor source	
Data type	**Energy[a]**	**Material**	**Energy**	**Material**
Best case	In-house/process-based data		For on-site production: in-house/primary For purchased electricity: supplier-specific or via a certification mechanism (e.g., guarantees of origin)[b] For other purchased energy: supplier-specific or well-characterized emission factors based on stoichiometry	Supplier-specific (e.g., via Pathfinder Network)
Best case[c]	In-house/process-based data		Secondary process-based sources	
Worst case	In-house/spend data		EEIO databases and data proxies	

a. Electricity, heating/cooling, steam.
b. Allowed only if mechanism excludes renewable energy purchased from regional grid mix.
c. Prevalent approach in practice.

Box 5: Market-based approaches

Further work is ongoing to understand the application of market-based approaches (e.g., purchases of carbon credits, value chain interventions, mass-balance certification, book-and-claim certification) in company and product GHG inventories. The aim is to standardize the accounting methodologies, reflected in the GHG Protocol's update to corporate, Scope 2, and Scope 3 standards. PACT will revisit the use of market-based mechanisms when further evidence from ongoing review of the accounting standards emerges.

The use of modeling tools to estimate GHG emissions is a common practice in many sectors (such as agriculture), where emissions calculation is complex and affected by several interrelated parameters (such as geography, temperature, type of input, and agricultural practice). For the purposes of this guidance, the results of a model that uses primary data as an input would also be considered primary.

4.1.3 Selecting secondary data

4.1.3.1 Activity data

As displayed in Table 6, activity data that is used to calculate product-level GHG emissions shall always be company-specific. However, this guidance acknowledges that there may be instances where company-specific process-based data may not be available (e.g., where there is no traceability in the value chain). In these instances, companies may resort to using spend-based data and EEIO emission factors for their PCF calculations ("worst case"), bearing in mind this will reflect negatively in their data quality assessment scores (see **Section 4.2.2**).

4.1.3.2 Emission factors

Primary emission factors are also not always available. For instance, suppliers may be unable to provide GHG data for a component required to manufacture the product for which Company X wishes to calculate a PCF. In such scenarios, emission factors from secondary sources should be used (base case).

The employment of secondary emission factors shall be compliant with the general quality rules for secondary data sources. To ensure the use of verified and credible secondary emission factors while still allowing for flexibility in the data sources used, the Pathfinder Framework defines a series of safeguards that secondary emission factors shall comply with if they are to be used for the calculation of PCFs:

1. Documentation:
    - Data included in the secondary emission factor shall be validated in line with globally recognized LCA principles.[29]
    - The emission factor source should ensure transparency by providing information on key methodological (i.e., LCA modeling approach, aggregation and allocation approach, if any) and data (time period, geography, technology, representativeness) elements.
2. Management and maintenance:
    - If life cycle inventory databases are used, they shall be periodically maintained and updated with the latest data sets.
3. Choice of modeling:
    - The modeling of the secondary emission factor shall be consistent with the methodological principles of this Framework (e.g., attributional approach).

Companies shall provide references to the main sources used for their PCF calculation, including the specific data set used, as part of the data exchange form. Examples of secondary emission factor sources can be found in Table 7 below.

4.1.4 Filling in data gaps

When primary and secondary data are not available, proxy data may be used to bridge minor data gaps (worst case). The selection of proxy data sets is usually based on the knowledge and experience of the LCA practitioners and the subject matter expert for that sector or product category.[30]

Table 7: Examples of secondary emission factor databases accepted under the Pathfinder Framework

Database	Sector	Link
Ecoinvent	All	https://www.ecoinvent.org/
GaBi (thinkstep)	All	http://www.gabi-software.com/international/databases
GLEC database	Transportation	https://www.smartfreightcentre.org/en/downloads/
Official national emission factor databases	All	E.g., US EPA database: https://cfpub.epa.gov/ghgdata/inventoryexplorer/
PEF	All	https://www.openlca.org/product-environmental-footprints-pefs-in-openlca/
UNEP Global LCA Data Access Network	All	https://www.globallcadataaccess.org/

4.2 Data reliability

This Framework introduces two metrics to track, report, and improve data quality, as well as increase the use of primary data. By managing these metrics, companies can assess and improve the overall quality of PCF calculations.

4.2.1 Introduction

Initially, companies shall calculate and report, as part of PCF data exchange, on at least one of the following metrics:

- **Primary Data Share (PDS).** Percentage of PCF emissions that were calculated using primary activity and emissions data (**Section 4.2.1**)
- **Data Quality Ratings (DQRs).** Quantitative score for five data quality indicators based on the data quality matrix (**Section 4.2.2**)

From 2025, both metrics shall be reported by companies to ensure continued alignment with the Pathfinder Framework. This will ensure a fuller picture of both the quality of the PCFs and the amount of primary data being used to calculate them. Until 2025, companies should base their initial choice of metric(s) on the relevance to their situation and resources available. For instance, a company calculating a PCF for the first time may not have access to a large amount of primary data and may wish instead to reflect on the accuracy of the secondary sources used to calculate its PCF.

4.2.2 Primary Data Share

To create visibility on the share of primary data in PCF calculations, the PDS in each data set should be determined and exchanged across the value chain. This can be done by calculating the proportion (percentage) of the total GHG emissions (CO_2e) that is derived using primary data:

$$\frac{\text{Part of PCF based on primary data } (CO_2e)}{\text{PCF } (CO_2e)} = PDS_{PCF}\ (\%)$$

In order for an input to be considered primary data, both the activity and emission factor shall be compliant with the primary data definitions included in Table 5 (see a clarifying example below, Table 8).

In order for the upstream emissions' PDS to be greater than 0, companies would need to request PCFs and their corresponding PDS from their suppliers. Should PDS for relevant components be obtained from upstream suppliers (tier n-1), the total PDS of the PCF should be calculated using a weighted average approach of the material and energy inputs based on their GHG contribution to the studied product's PCF.

To do so, the individual PDSs received from every input supplier ($PDSPCF_{component\ 1}$ and $PDSPCF_{component\ 2}$) as well as other components, such as energy inputs or direct emissions from

production, should be multiplied by their respective relative contribution (in percentage) to the PCF emissions. All weighted PDS components should then be added up to obtain an overarching PDS ($PDS_{PCF\ product}$) (Figure 15).

Figure 15: Calculation of PDS

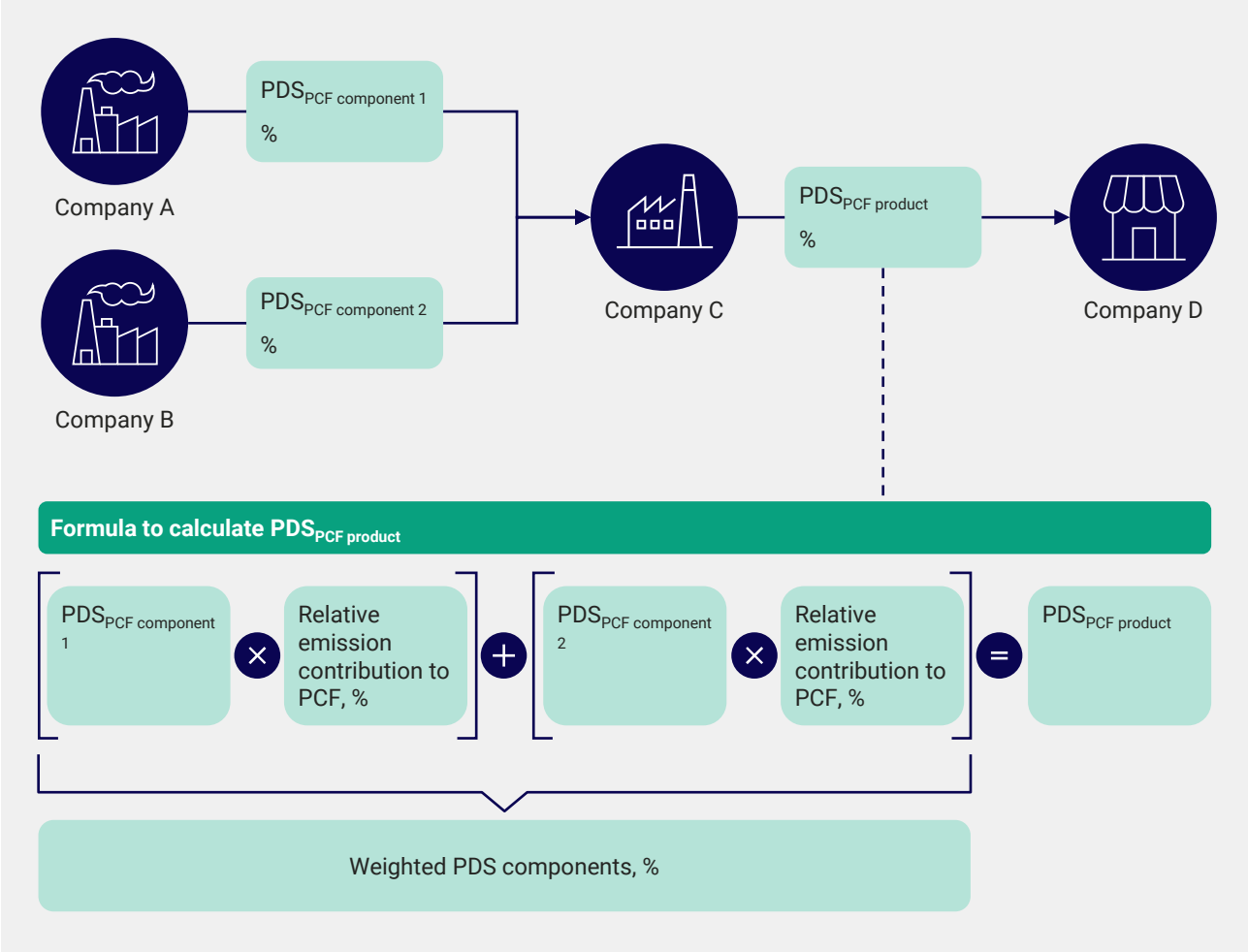


Table 8: Example of calculation of PDS

Component	Data input, kWh	Activity data source	Emission factor, $kgCO_2e$	Emission factor source	Total, $kgCO_2e$	PCF	Total PDS
$PDS_{PCF\ component\ 1}$	10,000	Primary	0.19	Primary	1,900	41%	41%
$PDS_{PCF\ component\ 2}$	10,000	Secondary	0.18	Secondary	1,800	39%	0%
$PDS_{PCF\ component\ 3}$	5,000	Primary	0.18	Secondary	900	20%	0%
					4,600		**41%**

Note: For the purpose of this example, please note that Component 1 is considered to have a PDS of 100%, since both the activity and emission factor data come from primary sources

To help increase transparency on primary data use, the overarching PDS ($PDS_{PCF\ product}$) should be exchanged downstream (tier n+1) together with the PCF.

The inclusion of an explanation for the share of primary data is thus encouraged, with the objective of helping businesses support each other in understanding the nature of the exchanged data and promoting an increase in the amount of primary data flowing through the system. This process will contribute to more accurate PCFs.

4.2.3 Data quality assessment

With companies able to calculate their PCFs using several data types, data quality assessments provide data users with a better understanding of the overall integrity of the data and the resulting PCF. Additionally, understanding the quality of the data allows companies to identify key secondary data sources that should be improved or replaced with primary data in order for companies to be able to track the impact of emissions reduction plans more accurately.

Once the GHG calculations for the PCF have been completed, companies undergoing the data quality assessment shall calculate a DQR for the following five indicators, defined in line with the GHG Protocol guidelines:

- **Technological representativeness.** The degree to which the data reflects the actual technology(ies) used in the process.[31]
- **Geographical representativeness.** The degree to which the data reflects the actual geographic location of the processes within the inventory boundary (e.g., country or region).[32]
- **Temporal representativeness.** The degree to which the data reflects the actual time (e.g., year) or age of the process.[33]
- **Completeness.** The degree to which the data is statistically representative of the process sites.
- **Reliability.** The degree to which the sources, data collection methods, and verification procedures used to obtain the data are dependable.

By adapting the data quality assessment matrix proposed by the GHG Protocol, subjectivity in the assessment will be minimized and a more clear-cut distinction across all levels ensured. The quality levels against which each indicator shall be assessed are 1—Good, 2—Fair, and 3—Poor (Table 9). This matrix shall be used by companies to derive quantitative DQRs for each of the indicators. Companies shall include in the assessment any contribution that represents at least 5 percent of the overall PCF.

To facilitate clarity and transparency, companies shall report the ratings of each data quality indicator separately. If a company produces the studied product in more than one site, it shall define the DQRs using the weighted average of production volumes of the respective sites.

Table 9: Streamlined version of GHG Protocol data quality assessment matrix

Data quality indicators	1 — Good	2 — Fair	3 — Poor
Technological representativeness	Same technology	Similar technology (based on secondary data sources)	Different or unknown technology
Temporal representativeness	Same reporting year	Less than 5 years old	More than 5 years old
Geographical representativeness	Same country or country subdivision	Same region or subregion	Global or unknown
Completeness	Activity data collected for all relevant sites for specified period	Activity data collected for <50% of sites for specified period or >50% of sites for shorter period	Activity data collected for <50% of sites for shorter time period or unknown
Reliability	Measured activity data	Activity data partly based on assumptions	Financial data or non-qualified estimate

The contributions of the different PCF components (i.e., material and energy inputs) to the final DQRs are determined via a weighted average based on their emissions contribution to the total PCF (see the formula below).

This is exemplified below (Table 10).

$$DQR_{indicator} = DQR_{component\ 1} \times \frac{PCF_{component\ 1}}{PCF_{total}} + DQR_{component\ 2} \times \frac{PCF_{component\ 2}}{PCF_{total}} + DQR_{component\ 3} \times \frac{PCF_{component\ 3}}{PCF_{total}}$$

Table 10: Example of data quality assessment

Data quality indicators	Component 1	Component 2	Component 3	Total DQR
GHG contribution to total PCF	**25%**	**30%**	**45%**	**100%**
Technological representativeness	2	1	1	1.25
Temporal representativeness	1	3	1	1.60
Geographical representativeness	2	3	3	2.75
Completeness	1	1	1	1.00
Reliability	2	3	2	2.30

Box 6: Improving data quality over time

The aim of data collection and quality assessments is to improve the overall accuracy of the product inventory and should thus be considered an iterative process to be completed alongside any calculation updates that may take place.

For instance, improving the quality of data for large emission sources can result in a significant improvement in the overall inventory quality. If significant data sources are identified as low quality using the data quality indicators, companies should aim to center their data collection and quality improvement efforts on these particular processes, either by engaging with their suppliers and requesting PCFs from them or by researching and assessing more accurate secondary data alternatives.

Please note that in certain cases, the reduction of PCF emissions may lead to a variance in the PDS or DQR scores reported by companies. For instance, if the electricity used to manufacture a product becomes 100 percent renewable, the share of emissions associated with electricity will decrease to almost zero, thus losing its representation in the PDS and DQR calculations. These variances caused in PDS and DQR should be communicated to the entities receiving the data to ensure the changes in PDS and DQR are not perceived negatively.

5. Assurance and verification

The resolution of the Scope 3 challenges businesses face today requires that high-quality (relevant, complete, consistent, transparent, and accurate) data can be shared across value chains. Assurance and verification ensure the reliability of this data, creating the necessary trust among all stakeholders to drive decarbonization at scale.

5.1 Context

While the Pathfinder Framework—as well as the existing methods and standards it builds on—paves the way toward data exchange, assurance and verification are key in ensuring the credibility and reliability of the exchanged data. Assurance and verification represent the two processes required to undergo a carbon audit. While verification is the process of evaluating the accuracy of carbon emissions disclosed by a company, assurance is the act of provision of an opinion based on the degree of confidence that is provided during the verification process. Since the requirements detailed in this guidance aim to enable standardized, high-quality carbon audit processes, this guidance will use both terms interchangeably.

Assurance and verification undertaken by independent verifiers can help establish whether PCFs have been accounted for in compliance with the Pathfinder Framework and relevant standards, sectoral guidance, PCRs, and accompanying methods.

This section provides guidance and requirements for assurance and verification of PCF results taking place in the context of the Pathfinder Framework.

5.2 Objectives and scope

5.2.1 Objectives

The overarching objective of this section is to define the requirements around assurance and verification of PCFs in alignment with the Pathfinder Framework.

By clearly defining requirements, this guidance seeks to:

- Establish a common basis and language around assurance and verification for all stakeholders in the ecosystem
- Increase the uptake of product-level assurance and verification practices across industries via a phased-in approach
- Provide clarity on future assurance and verification requirements to support the preparation process for stakeholders wishing to remain aligned with the Framework's assurance requirements
- Streamline the assurance and verification process by providing guidance on what evidence companies need to prepare for an assurance engagement

5.2.2 Scope and limitations

This guidance defines the minimum assurance and verification requirements companies shall fulfill when exchanging data through the Pathfinder Network. However, companies are strongly encouraged to align with the longer-term requirements defined in this guidance as early as possible, increasing emissions data reliability and trust in the overall ecosystem. Going beyond the minimum requirements of assurance and verification will also be reflected in the data exchange (**Section 1**), allowing companies to distinguish themselves through greater data credibility.

From a practical standpoint, verified PCF data obtained from another upstream supply chain stakeholder not only increases credibility in the data received, but also reduces the cost of a company's own audit. The reasoning is that verified PCFs shall not need to be (re)verified if used for calculations of a company's own PCF, as long as no changes are made to the underlying calculation models and data used by the company that shared the data in the first place.

This guidance recognizes that assurance and verification of emissions disclosures involves many challenges, including:

- The limited visibility and control of companies over emission sources
- Assurers' limited ability to obtain sufficient evidence on all necessary items
- The evolving scientific consensus on questions directly affecting emissions disclosures, such as emission intensity factors
- The required subject-matter expertise that not all companies and assurers may currently have at scale

The Pathfinder Framework seeks to help mitigate these challenges by providing clarity and a reference point. Nonetheless, companies and assurers should continue to collaborate to assure PCFs to the best of their knowledge and improve emissions disclosure assurance and verification practices across different sectors.

Finally, it is important to note that this guidance is not by itself intended to be used as an assurance standard. It defines the requirements and proposed outcomes of the assurance process (i.e., the "what" of assurance) but does not prescribe the assurance process itself (i.e., the "how" of the assurance process). Assurance providers should therefore refer to additional assurance standards when verifying PCF data and methodology in the context of the Pathfinder Framework.

5.3 Assurance roadmap

5.3.1 Structure

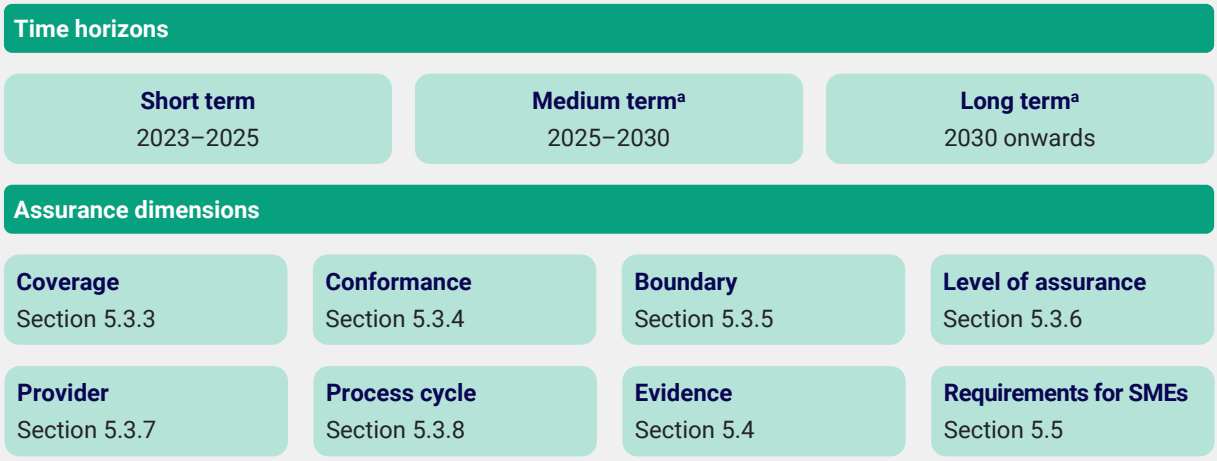
This guidance is structured as a roadmap consisting of three time horizons, each one encompassing requirements across eight assurance and verification dimensions, as shown in Figure 16. While some of the long-term requirements, applicable starting in 2030, would currently be challenging to fulfill, this guidance assumes that the evolution of carbon accounting technology, the methodological ecosystem, and auditing practice will significantly enhance companies' ability to comply. However, if necessary, long-term requirements could be revised.

5.3.2 Overview

Figure 17 presents an overview of the Framework's assurance and verification requirements for the three time horizons by dimension.

The following sections provide further details on each dimension and requirement.

Figure 16: Time horizons and dimensions of the assurance roadmap



a. Requirements to be fulfilled for PCFs being updated after 2025 for the medium term and after 2030 for the long term.

Figure 17: Assurance roadmap overview

Dimension	Short-term requirements 2023–2025	Medium-term requirements 2025–2030	Long-term requirements 2030 onwards
Coverage Granularity of data to be assured	Corporate level	Representative product or PCF system	Representative product or PCF system
Conformance Basis for the assurance	Any recognized standard	PCR or sector-specific guidance, if followed If not, Pathfinder Framework	PCR or sector-specific guidance, if followed If not, Pathfinder Framework
Boundary Depth of the data to be assured	Gate-to-gate Scope 1 and 2 for corporate-level	Cradle-to-gate	Cradle-to-gate
Level Degree of confidence	Limited assurance	Limited assurance	Reasonable assurance
Provider Entity providing the assurance	Independent third party	Independent third party	Independent third party
Process cycle Temporal validity of the assurance	Annual	3 years or earlier if variance >10%	3 years or earlier if variance >10%
Evidence Guidance for consolidation	**Evidence pack guidance** Companies should use guidance around evidence consolidation (see Appendix D) to facilitate and streamline the assurance process		
Application to SMEs SME requirements	**Phased-in approach for SMEs** All requirements above identically apply to SMEs but with a 2-year time lag to allow for capacity building		

5.3.3 Coverage

The coverage of the assurance and verification defines the type and level of GHG data to be assured (e.g., corporate level, product line level, or PCF level).

Short term

Companies shall assure emissions data at the corporate level. Assurance on a more product-specific level, such as product line or product level, is desirable but not required.

Medium term

Companies shall assure PCFs are aligned with Pathfinder Framework requirements:

- At the product-line level, where the PCF of a representative product is assured
- By verifying the underlying methodology used by a system (e.g., software) for the purpose of PCF calculation

The rationale behind these options is to approach and build capabilities around product-level assurance without requiring product-specific assurance directly. Figure 18 below gives an overview of the definitions and steps that companies shall comply with when following either of these approaches.

Please note that companies may still need to verify specific PCFs at the product level if regulations or customers require it.

Long term

In the long term, companies shall follow the same requirements as in the medium term.

Figure 18: Assurance coverage options in the medium term

	Step 1	Step 2	Step 3
Option A: product line Representative product sharing key characteristics with group of products (e.g., purpose, materials, or manufacturing process)	Pick representative product (RP) by defining the product line it represents based on the above definition	Assure RP following Pathfinder Framework requirements	Use assurance statement of RP as proof of verification for any product within product line, provided explanation on representativeness is given
Option B: PCF calculation system Calculation tool applicable across products used by companies to convert raw data inputs into a finalized PCF	Define what constitutes the PCF system, i.e., whether there is only one software tool or several interconnected tools	Assure whether the tool(s) calculate(s) company PCFs following Pathfinder Framework requirements	Use assurance statement of PCF system as proof of calculation being aligned with Pathfinder Framework. Communicate data inputs have not been assured

5.3.4 Conformance

The assurance process verifies whether emissions data output was calculated according to methodological rules. The conformance of the assurance defines adherence to which standard is verified, i.e., which methodological standards serves as the reference.

Short term

Companies may use any recognized standard included in **Appendix C** has the basis for corporate-level assurance. Companies wishing to go beyond the minimum coverage requirements of this guidance and assure on a product-specific level may use any recognized standard as the basis for assurance.

Medium term

Companies should use the Pathfinder Framework as the methodological basis for assurance and verification. Please note that, in line with the standards hierarchy established in **Section 3.1**, companies may be required to calculate certain PCFs following PCR or sector-specific guidelines. In those cases, conformance with the PCR or sector specific methodology shall be followed. To the extent possible and relevant, conformance with the Pathfinder Framework is encouraged, but not required. Any PCR or sector-specific methodology or standard used shall be publicly disclosed and referenced in the assurance and verification process as well as in the data exchange information to ensure downstream users of the information have a complete understanding of the conformance of the PCF.

Long term

Companies shall follow the same requirements as in the medium term.

5.3.5 Boundary

The boundary of the assurance and verification, as its name suggests, defines the boundary of life cycle stages included in the assurance process. While the PCFs exchanged under the Pathfinder Framework are cradle-to-gate footprints, the boundary of the assurance and verification of the PCF can be broader, narrower, or equal to the boundary of the PCF.

Short term

Companies shall assure their gate-to-gate emissions. This requirement is, in part, a consequence of the initial corporate-level coverage requirement (see **Section 5.3.3**). In the context of this guidance and in line with the corporate-level coverage requirement, gate-to-gate emissions on the company level are considered to be equivalent to Scope 1 and Scope 2 emissions, as defined by the GHG Protocol.

Medium term

Companies shall ensure that the entire cradle-to-gate footprint of PCFs has been verified, i.e., the entire footprint up to the point where it is passed on downstream (see Figure 5).

Long term

Companies shall follow the same requirements as in the medium term.

5.3.6 Level of assurance

The level of assurance defines the degree of confidence in the assurance statement. Box 7 provides further context on assurance levels.[34]

Short term

Companies are required to conduct limited assurance.

Medium term

Companies shall follow the same requirements as in the short term.

Long term

Companies shall conduct reasonable assurance to fulfill the requirements of this guidance.

Box 7: Assurance levels

Why?

To ensure all stakeholders understand the degree to which emissions disclosures have been verified. The goal is to enable:

- Companies to plan the assurance process and depth of verification they desire
- Assurers to prepare the verification according to standardized practices
- External stakeholders, such as downstream companies, to understand the reliability of the reported data

What?

There are two assurance levels commonly used in emissions disclosure assurance:

- Limited level. The conclusion of a limited level of assurance is framed in a negative sense, indicating that the assurer did not find any evidence that the emission disclosures contain any material misstatement based on the applicable criteria.
- Reasonable level. The conclusion of a reasonable level of assurance is framed in a positive sense, indicating that, according to the assurer, the emission disclosures have been prepared according to the applicable criteria in all material aspects.

Table 11 provides an additional overview of the different characteristics of the two levels.

How?

Companies should define which level of assurance they are going to seek before an assurance engagement, in line with the requirements set by this guidance. The assurance provider may suggest adjustments if they believe the desired level will not be feasible (provided that the minimum requirements of this guidance are met).

Table 11: Assurance levels comparison

Dimension	Level	
Aspects	Limited assurance	Reasonable assurance
Opinion statements	Negative "Nothing has come to our attention that the assurance statement does not conform with the Pathfinder Framework and contains material misstatements"	Positive "In our opinion the disclosure conforms with all Pathfinder requirements and is fairly stated in all material aspects"
Application	Commonly used for nonfinancial disclosures	Commonly used in financial disclosures
Process	Limited in Scope—different or fewer checks than reasonable assurance	Greater sampling at a greater depth and comprehensiveness

5.3.7 Provider

The provider of the assurance is the entity that verifies the emissions data. When the reporting company also performs the assurance, this is known as first-party assurance. When a party other than the reporting company performs the assurance, this is known as third-party assurance.[35]

Companies shall choose an independent third party to conduct the verification process. While first-party quality controls and plausibility checks are encouraged, they do not suffice to fulfill the assurance requirements of this guidance.

Companies may choose any qualified assurance provider, as long as the provider meets the expertise requirements to conduct an assurance engagement. Proof of such expertise may include previous assurance engagements around PCFs, industry-specific knowledge, and technical capabilities in carbon accounting. **Section 5.6.2** provides additional details on criteria to consider when selecting an assurance provider.

5.3.8 Process cycle

The process cycle defines the validity period of the assurance statement (e.g., one year or more).

Short term

In line with the coverage requirement (see **Section 5.3.2**), the assurance statement shall be valid for one year. Accordingly, companies shall renew the assurance annually. The requirement for an annual renewal of assurance on the corporate level aims to be aligned with regulatory requirements such as the EU's Corporate Sustainability Disclosure Directive (CSRD) and the US Securities and Exchange Commission's (SEC) proposed rules on nonfinancial disclosures.

Medium term

The assurance statement shall be valid for a maximum of three years or until:

- The underlying PCF of the representative product changes by more than 10 percent compared to the PCF that was previously assured, if the company chooses to assure on the product-line level
- The PCF system's underlying methodology or system build has changed qualitatively. A qualitative change includes:
  - Relevant fixes or changes with the existing PCF system
  - Deployment of a different PCF system product (e.g., switch to a different vendor or change in product line of same vendor)
  - Changes to the data flows necessary for PCF calculation within the PCF system (e.g., when the type of digital input data has changed or when there is a qualitative change to other digital systems participating in PCF calculation)

Long term

Companies shall follow the same requirements as in the medium term.

5.4 Evidence

5.4.1 Context and purpose

The provision of standardized and relevant evidence to substantiate emissions claims and support the assurance process is the cornerstone of any verification and assurance process.

This section is therefore meant to guide companies' efforts to gather and organize the evidence that might be required in an assurance engagement. This guidance does not replace any guidance that assurers themselves may provide during the verification process and is not a blueprint for an assurance engagement. Rather, it is meant to help companies prepare for an assurance engagement ahead of time, speeding up and streamlining the assurance process.

5.4.2 Structure and dimensions

The guidance around evidence is structured along three dimensions central to verifying product-level emission disclosures:

1. **Data.** Evidence around the required data elements, sources, and quality of data used in the calculations
2. **Methodology.** Evidence around the calculation steps, results, and assumptions
3. **Governance.** Evidence around the underlying processes used during the calculations, including how data was stored, how quality was ensured, and how risks were mitigated

Each dimension contains five concrete elements listed in **Appendix D** that constitute the evidence pack for that dimension. As the maturity of companies' product-level emission reporting varies, the evidence pack distinguishes between minimum and optional elements that might bring further clarity to the assurance process.

5.4.3 Assumptions

In providing guidance on evidence, the assumptions listed in Table 12 below were made. Not all of them may apply to a company's situation; companies should therefore check to what extent the assumptions are applicable and, accordingly, to what extent this guidance may be relevant for their context.

5.4.4 Evidence pack

A full version of the evidence pack, including the different dimensions and minimum and optional requirements, is included in **Appendix D**.

5.5 Requirements for SMEs

While this guidance encourages any company to assure its emissions data according to the requirements laid out in Figure 17, small and medium-sized enterprises (SMEs)[36] may face additional challenges in meeting assurance and verification requirements due to initial resource and capability constraints.

To give SMEs time to build the necessary capabilities to fulfill assurance and verification requirements, each requirement as defined in **Section 5.3.2** shall become applicable for SMEs two years after the requirement first comes into force for larger companies. For example, short-term requirements as per Figure 17 shall become applicable for SMEs in 2025.

While these are the minimum requirements, it is strongly encouraged that SMEs begin to meet the assurance and verification requirements sooner than they are required to by this guidance.

Table 12: Key evidence consolidation assumptions

Assumption	Explanation
Product level	This evidence pack assumes that the carbon emissions data is calculated on the product level. It therefore does not apply to corporate-level emission disclosure assurance engagements
PCF already exists	This evidence pack assumes that the relevant PCF has already been calculated. It does not contain guidance around how to calculate a PCF
Level agnostic	This evidence pack assumes that the assurance level is either limited or reasonable. The guidance provided here is therefore applicable to either level

5.6 Process and reporting

5.6.1 Timing

Assurance engagements in the context of this guidance shall begin after the result to be assured, e.g., a PCF, has been calculated and before the result is exchanged through the Pathfinder Network. Given that the verification process may take time, depending on the complexity of the underlying emissions disclosure, it is the company's responsibility to start the assurance and verification process early enough to avoid delays to data exchange.

5.6.2 Requirements for choosing assurance providers

While this guidance does not include specific requirements around choosing an assurance provider, the following criteria may be used to select assurance providers:

1. Expertise and experience:
    - Proven experience conducting assurance engagements and applying assurance standards
    - Capabilities around LCA and carbon accounting, as shown by experience, educational qualifications, and tools used
2. Industry and sectoral knowledge:
    - Understanding of the underlying industry that the PCF data to be assured belongs to
    - Understanding of business operations within the sector which the product or corporation belongs to
3. Credibility:
    - Proof of no conflicts of interest between the assurance provider and reporting company
    - Proof of successful verification processes
4. Capacity:
    - Enough staff capacity to conduct the assurance engagement

5.6.3 Reporting

In line with the GHG Product Standard, companies shall include the assurance statement in the emission disclosure. An assurance statement, at the minimum, shall include:

- The assurer's assertion
- The level of assurance
- The assurance provider's name and the executing individuals
- A summary of the assurance process and work performed
- The relevant expertise of the assurer
- Any potential conflicts of interest
- The assurance standard applied, if any
- A list of criteria that were evaluated to reach the assertion.

The format of reporting will depend on the applicable requirements, particularly the coverage requirements.

In the short term, companies shall report the assurance statement alongside the relevant emissions disclosure. In the medium and long term, companies shall need to share the assurance statement as a link in the data attributes or as an attachment to the relevant PCF being exchanged, i.e., the reporting of assurance-related information will directly be part of the data exchange.

In general, companies shall exchange information on the assurance itself through the Pathfinder Network. It is the company's responsibility to ensure that assurance-related information for each PCF exchanged through the Pathfinder Network is up to date and aligned with the requirements of this guidance.

5.7 Special cases

5.7.1 Existing assurance

It may be the case that a company needs to verify carbon emissions disclosure for purposes other than adherence to this guidance, e.g., to fulfill reporting or regulatory requirements. If verification has already taken place, even if not for the purposes of exchanging data through the Pathfinder Network, the resulting assurance may be used for the assurance requirements of the Pathfinder Framework provided that the existing assurance conforms to the applicable requirements of this guidance at the time the assurance was undertaken.

5.7.2 Conformance based on Pathfinder hierarchy

If a company uses an industry-specific standard or PCR for its PCF calculation, as described in Section 3.1.2, and if that standard or rule includes an assurance requirement, then the company may fulfill the assurance requirement of the standard used without having to fulfill the requirements of this guidance in case they do not fully align. However, companies shall indicate in the data exchange form which standard was followed, what the assurance requirements of that standard entail, and any potential divergence from the requirements of this guidance.

5.7.3 Partial or noncompliance with this guidance

If a company is unable to meet the assurance and verification requirements as defined in this guidance before exchanging the data, the company may still exchange it through the Pathfinder Network. However, the reporting company shall make transparent, through the Data Exchange Protocol and the relevant data attributes, to what extent the assurance requirements were fulfilled or not.

6. Data exchange

Standardized PCF accounting and data exchange constitutes a key step toward creating greater comparability and consistency within the supply chain.

6.1 Required elements for data exchange

Emissions data calculated in line with the Pathfinder Framework shall be exchanged in accordance with the guidelines set out in this section.

Once a company has calculated its PCF, another factor to enhance comparability and consistency is the standardized exchange of data relating to the PCF between stakeholders within the supply chain. Emissions data calculated in line with the Pathfinder Framework shall therefore be exchanged in accordance with the guidelines set out in this section.

6.1.1 Minimum data elements required

As a minimum, the following data elements shall be exchanged with a data recipient within a value chain:

- Product information:
  - Data provider's company name
  - Product name, short description of the production technology (if relevant), and unique UN Central Product Classification code[37]
  - Declared unit (e.g., mass or energy, depending on the product) and number of declared units contained within the product which the PCF refers to

- PCF information:
  - Reporting period (see **Section 6.1.2.1**)
  - Geography (see **Section 6.1.2.2**)
  - Product-specific PCF (CO_2e per unit of analysis), covering cradle-to-gate fossil emissions (see **Section 3.2**):
    - Excluding biogenic emissions and removals
    - Including biogenic emissions and removals (to be mandated only from 2025 onwards—see **Section 3.3.2.1**)[38]
  - Biogenic carbon content (see **Section 3.3.2.1**)[38]
  - IPCC version of the GWP characterization factors used in the calculation of the PCF (see **Section 3.2.2**)[38]
  - Boundary, including a description of all attributable processes per life cycle stage, as well as exclusions, if any (see **Section 3.2.3**)
  - Standards used for calculating or allocating GHG emissions (including PEF, PEFCRs, PCRs, sector-specific initiatives, GHG Protocol, ISO) and any additional approaches used (e.g., mandatory flagging when proxy data is used) (see **Section 3.1**)[38]
- Data reliability. Companies to share at least one of the two attributes below:
  - Share of primary data in a PCF (see **Section 4.2.1**)
  - Data quality indicators (see **Section 4.2.2**)[38]
- Assurance information (see **Section 5**)[38]

Further details on data semantics and standards can be found in the Pathfinder Network Technical Specifications. Many companies already use software solutions and are thus encouraged to exchange data digitally (see **Section 6.2**). However, companies that do not yet employ software solutions to calculate their PCFs are welcome to exchange the data using the template included in **Appendix B**.

6.1.2 Details on the required data elements

6.1.2.1 Time boundary

The time boundary of a PCF refers to the time period for which the PCF value is considered to be representative.[39]

While PCFs should be calculated on a regular basis to track improvements over time, the resources required to calculate PCFs also need to be considered to ensure companies are able to scale the calculations to a larger number of products. This is especially true for companies that currently rely on manual PCF calculations and that do not yet have an automated calculation approach.

PCFs shall therefore have a maximum validity period of up to three years, provided that no major changes to the production process take place within the validity period. Major changes are defined as a variance of 10 percent or more compared to the original PCF. After three years or if the PCF has varied by more than 10 percent, PCF values will no longer be considered representative and shall be recalculated and exchanged.

Companies that are able to do so are invited to update their PCFs more regularly and may also wish to request suppliers to update their PCF calculations on a more regular basis (e.g., annually) based on contractual agreements.

The temporal validity of the PCF calculation will be captured by the reporting period.[40] The PCF's reporting period and date of publication shall always be disclosed. Emissions that were averaged over several years may be reported, e.g., to reduce the effect of revisions, turnarounds, or other untypical production conditions.

6.1.2.2 Geography

Providing information on the geographical representation of the PCF is required. However, it is at the sole discretion of the company to choose the level of granularity of geographical information (e.g., at a plant, region, or country level). ISO 3166-1 alpha-2—defining the most widely used country codes (such as US for the United States or FR for France)—shall be used to indicate specific countries or regions. If the same product is produced in various locations and the data owner chooses to provide regional information, the data owner can provide several product footprints pertaining to each respective geography. As an alternative, it is possible to report a single footprint for products that are produced in various locations. When following this approach, a weighted average of the respective product-specific emissions according to each geography's production quantity shall be calculated and exchanged.

6.2 Connecting through technology

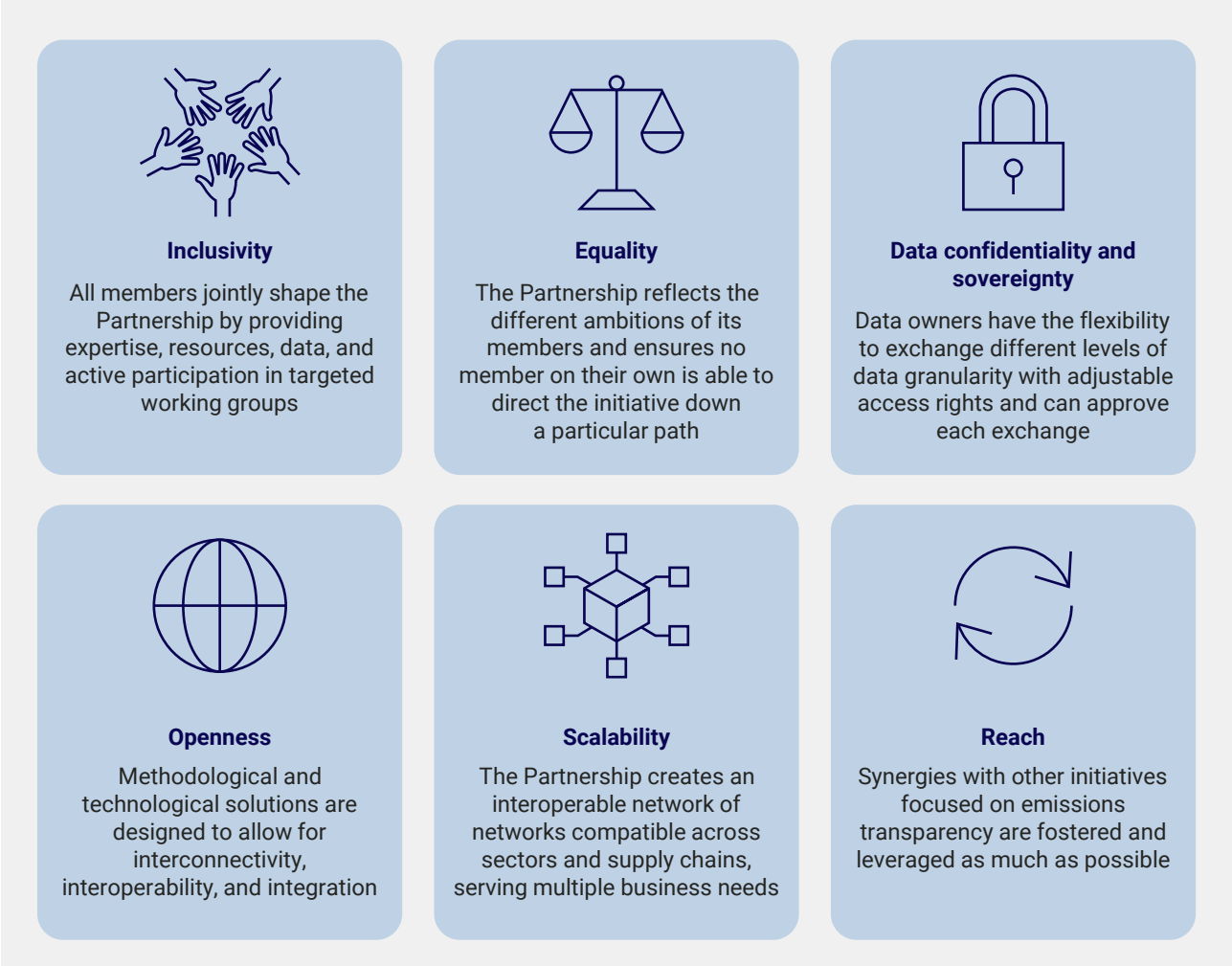
Application of the guidance in this Pathfinder Framework will help businesses create more comparable and consistent product-level GHG emissions. However, to comprehensively tackle the lack of emissions transparency, it is equally essential to enable straightforward and confidential cross–value chain and cross-industry exchange of such data.

Technology is without a doubt a key driving force in enabling straightforward and confidential cross–value chain and cross-industry exchange of product-level emissions data. Beyond the creation of this Framework, stakeholders within PACT are also collaborating on developing a network for the exchange of emissions data (Pathfinder Network). The aim is to establish the missing (technological) link between companies through the creation of an interoperable ecosystem, connecting multiple underlying technology solutions and in turn incentivizing the latter to provide support in their products for the import and export of data in the PACT format(s).

In addition, the Network can strengthen the application of the Pathfinder Framework—and hence achievement of data comparability and consistency—by, e.g., simplifying access to primary data or supporting data verification.

The Pathfinder Network will be underpinned by the key values of PACT (Figure 19).

Figure 19: Key values of PACT



6.3 Incorporating product-level data into Scope 3 calculations

By establishing a plan to expand the number of purchased products and services being calculated with primary data, transparency on emissions can be progressively created across upstream emissions of a company.

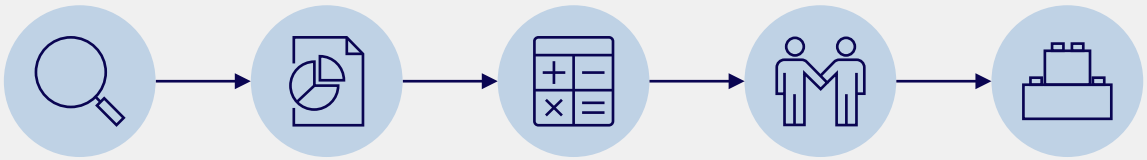
Corporate- and product-level standards are highly interrelated, since emissions resulting from the procurement of products and services represent the largest share of corporate Scope 3 emissions in most sectors. Management of these is therefore highly dependent on high-quality accounting for product-level emissions.

While the GHG Scope 3 Standard accepts several methods to account for upstream Scope 3 emissions (**Appendix E**), obtaining emissions data directly from suppliers is considered best practice. While requiring greater effort, this approach allows companies to collaborate with their supply chain to improve the efficiency of products and services purchased and accurately monitor the impact of these improvements on their footprint. This, in turn, can become a procurement criterion rewarding those that are more sustainable or even supporting suppliers in their emissions reduction journeys.

It is important to note that the shift to supplier-specific product-level data can be done gradually by combining PCFs with other Scope 3 accounting methods for the less material elements.

By establishing a plan to expand the number of purchased products and services being calculated with primary data, transparency on emissions can be progressively created across upstream emissions of a company. Similarly, by incentivizing Tier 1 suppliers to do the same, transparency will be expanded across the value chain. With this knowledge, companies can make informed sourcing and product-development decisions, investing in targeted decarbonization activities in their supply chains, measuring and tracking decarbonization progress, and adhering to requirements around environmental transparency. All of this will create deep visibility on the emissions of hundreds of thousands of companies sitting in global supply chains, providing the missing key to supercharging decarbonization efforts.

Figure 20: Recommendation for use of Pathfinder Framework to enhance transparency



Step 1
Identify the largest sources of emissions at either purchased product or supplier level based on initial Scope 3 calculation.

Step 2
Request suppliers associated with the most material sources to calculate and provide the relevant PCFs following the Pathfinder Framework and Pathfinder Network requirements.

Step 3
Incorporate PCFs into their corporate footprint by multiplying the PCFs provided by suppliers with the number of product units purchased from them.

Step 4
Work with suppliers to understand the PCF emissions trajectory or identify and implement opportunities to further reduce their PCF emissions, ultimately favoring suppliers with lower PCFs for equivalent products.

Step 5
Gradually incorporate additional products and suppliers into the PCF data exchange request.

Appendix A: Terms and definitions (glossary)

Definitions	Explanations
Activity data	Quantified measures of a level of activity that results in GHG emissions or removals.
Allocation	The process of partitioning GHG emissions from a single facility or other systems (such as a process vehicle or business unit) among its various outputs, in particular products.
Attributable process	Service, material, and energy flows that become the product, make the product, and carry the product through its life cycle.
Attributional approach	Approach to LCA accounting where GHG emissions and removals are attributed to the unit of analysis of the studied product by linking together attributable processes along its life cycle.
Biogenic carbon	Carbon derived from living organisms or biological processes, but not fossilized materials or fossil sources.
Biogenic CO_2 emissions	Emissions resulting from the combustion of biogenic fuel, broken down into land use (e.g., agricultural practices), land-use change (e.g., deforestation), and other (e.g., biogenic waste treatment) emissions; to remain optional until GHG Protocol FLAG standard is published.
Biogenic CO_2 withdrawal	Biogenic carbon content converted into CO_2e.
Boundary	The attributable processes and their associated emissions that should be accounted for and reported by a company as part of its PCF.
Carbon dioxide equivalent (CO_2e)	Unit comparing the radiative forcing (global warming impact) of a GHG, expressed in terms of the amount of CO_2 that would have an equivalent impact.
Characterization factors	A characterization factor is a quantitative representation of the (relative) importance of a specific intervention, e.g., the GWP (GWP 100) of methane is 22 kg CO_2e/kg.
Corporate-level standards	Corporate-level standards (such as ISO 14064 or the GHG Protocol Corporate Value Chain Standard) focus on aggregate emissions arising from the value chain of a company and apply to company activities as a whole, including business travel and employee commuting.
Cradle-to-gate PCF	Part of a product's full life cycle, covering all emissions allocated to a product upstream of a company plus all emissions resulting from processes within the company until the product leaves the company's gate.

Definitions	Explanations
Data quality	Characteristics of data (completeness, reliability and technological, temporal and geographical representativeness) that relate to their ability to satisfy stated requirements (the most common frameworks are the pedigree matrix [ecoinvent] and the data quality matrix/ requirements [PCRs]).
Data semantics	Naming, format, and definition of the data attributes required to be exchanged by the company calculating the PCF.
Declared unit	Unit of analysis chosen for PCF, which serves as the reference for which the inputs (materials and energy) and outputs (such as products, by-products, waste) are quantified.
Default value	Average value reflecting the mainstream level of the industry (such as material composition ratio of passenger car, carbon emission factor of material production, carbon emission factor of vehicle production, etc.).
Definitions	Explanations.
Direct emissions	Data on emissions released from a process (or removals absorbed from the atmosphere) determined through direct monitoring, stoichiometry, mass balance, or similar methods.
Direct land-use change (dLUC)	A recent (i.e., previous 20 years) carbon stock loss due to land conversion directly on the area of land under consideration.
Downstream emissions	Indirect GHG emissions that occur in the value chain following the processes owned or controlled by the reporting company.
Emission factor	Amount of GHGs emitted, expressed as CO_2e and relative to a unit of activity (e.g., kg of CO_2e per declared unit).
Environmentally extended input output (EEIO)	Models used to estimate energy use and/or GHG emissions resulting from the production and upstream supply chain activities of different sectors and products within an economy. EEIO models are derived by allocating national GHG emissions to groups of finished products based on economic flows between industry sectors.
Functional unit	Unit based on the function and performance of the studied product
Greenhouse gases (GHGs)	Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, its atmosphere, and clouds. GHGs include $CDCO_2$, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
Indirect land-use change (iLUC)	A recent (i.e., previous 20 years) carbon stock loss due to land conversion on land not owned or controlled by the company or in its supply chain, induced by change in demand for products produced or sourced by the company.
Input	Product, material, or energy flow that enters a unit process.
Inventory	Summary of all input and output flows of a system (such as a company's or product's GHG emissions and sources).

Definitions	Explanations
Inventory results	GHG impact of the studied product per unit of analysis.
Life cycle	Consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to end-of-life, inclusive of any recycling or recovery activity.
Life cycle assessment (LCA)	Compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product throughout its entire life cycle.
Land management GHG emissions	GHG emissions from sources that occur on land from land management activities and during production of food, feed, fiber, or other biogenic product(s). Land management GHG emissions are also referred to as agricultural emissions, production emissions, or on-farm emissions.
Life cycle emissions	The sum of GHG emissions resulting from all stages of the life cycle of a product and within the specified boundaries of the product.
Material	Physical products supplied from a supplier upstream, used as input for production processes of products.
Multi-input/output unit process	Operation or process with multiple inputs, such as materials and energy, and multiple outputs, such as co-products and waste.
Output	Product, material, or energy that leaves a unit process.
Partnership for Carbon Transparency (PACT)	A project led by WBCSD set up to provide a forum for businesses across value chains and industries as well as for key decarbonization stakeholders to collaborate on the creation of GHG emissions transparency.
Pathfinder Network	Network for the exchange of carbon footprint data that is being developed by the Partnership for Carbon Transparency, with the aim of establishing the missing (technological) link between different supply chain actors, such as through the creation of interoperability for underlying technology solutions.
Primary data	Data pertaining to a specific product or activity within a company's value chain. Such data may take the form of activity data, emissions, or emission factors. Primary data is site-specific, company-specific (if there are multiple sites for the same product), or supply chain–specific. Primary data may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, material or product balances, stoichiometry, or other methods.
Product	Any good (tangible product, such as material) or service (intangible product).
Product carbon footprint (PCF)	Total GHG emissions generated during the life cycle of a product measured in CO_2e. Within the boundary of the Pathfinder Framework, only material acquisition, preprocessing, production, distribution, and storage are included in the PCF.
Product category	Group of products that can fulfill equivalent functions.
Product category rules (PCRs)	A set of specific rules, requirements, and guidelines for calculating PCFs (among other things) and developing environmental declarations for one or more product categories according to BS EN ISO 14040:2006.

Definitions	Explanations
Product-level standards	Product-level standards (such as ISO 14067 or the GHG Product Standard) focus on individual products or services. They support accounting for products' life cycle emissions (see Section 3.3 for details on the stages). In doing so, they enable a more granular approach compared to company accounting, offering insights to help identify targeted emission reduction opportunities.
Proxy data	Data used to bridge data gaps without changing the original values beyond statistical calculations, such as averaging. The selection and use of proxy data sets is usually based on the knowledge and experience of the LCA practitioner, and the possibility to validate such choices is often limited.
Raw material	Primary or secondary material used to produce a product.
Site-specific data	Initial data obtained within a production system
Scope 3 emissions	The GHG Protocol Corporate Standard classifies a company's GHG emissions into three Scopes: Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.
Secondary data	Data that is not from specific activities within a company's value chain but from databases, based on averages, scientific reports, or other sources.
Tier 1 suppliers	Suppliers that companies directly conduct business with, including contracted manufacturing facilities or production partners.
Unit process	Smallest part of a product's life cycle for which input and output data is quantified.
Upstream emissions	Indirect GHG emissions that occur in the value chain prior to the processes owned or controlled by the reporting company. All upstream transportation emissions are also included as part of upstream emissions.
Use phase	That part of the life cycle of a product that occurs between the transfer of the product to the consumer and the end-of-life of the product.
Value chain	All the upstream and downstream activities associated with the operations of a company.
Waste	Materials, co-products, products, or emissions without economic value that the holder discards, intends to discard, or is required to discard.

Appendix B: PCF questionnaire

This PCF questionnaire contains the information that companies shall include to report their PCF according to the Pathfinder Framework. Please refer to full technical specifications for further information.

Product information		
Data attribute	**Description**	**Mandatory**
ID	Unique identifier of the PCF.	Yes
Technical specification: version	Identifier to define the version of the Pathfinder Framework used (e.g., "2.0.0").	Yes
Time created	The UTC timestamp indicating when the PCF was created.	Yes
Time updated	The UTC timestamp indicating when the PCF was updated, if at all.	No
Company name	The name of the data provider of the PCF.	Yes
Company IDs	The set of company identifiers (encoded as URNs) identifying the company sending the PCF, depending on the context and the two parties exchanging the data.	Yes
Product descriptions	A free-form description of the product and any related information, such as production technologies.	Yes
Product IDs	The set of product identifiers (encoded as URNs) identifying the product, depending on the context and the two parties exchanging the data.	Yes
Product category UN Central Product Classification	The category of the product based on UN Product Classification codes.	Yes
Product name	The trade name of the product as given by the selling company.	Yes
Digital record signature	Digital signature covering the full PCF. The technical specifications specify details on company identification and digital signature verification.	No
Comment	Any comments related to the product that facilitate the interpretation or verification of the PCF.	Yes

PCF information		
Data attribute	**Description**	**Mandatory**
PCF (excl. biogenic emissions and removals)	The product carbon footprint of the product, excluding biogenic emissions, in kg CO_2e per declared unit.	Yes
PCF (incl. biogenic emissions and removals)	The product carbon footprint of the product, including fossil and biogenic emissions (dLUC, land management, other biogenic emissions, and biogenic CO_2 withdrawal), in kg CO_2e per declared unit.	Yes, from 2025 onwards
Declared unit	The unit in which the PCF was calculated: liter, kilogram, cubic meter, kilowatt hour, megajoule, ton kilometer, or square meter.	Yes
Reporting period	The start and end date and time of the data collected for the underlying PCF calculation.	Yes
Geography	The location that the PCF refers to; different levels of granularity can be provided, ranging from country subdivision to global.	Yes
Product amount	The amount of declared units contained within the product to which the PCF refers.	Yes
Boundary process description	Description of the processes attributable to each life cycle stage.	Yes
Characterization factors	In the context of this guidance, characterization factors refer to GWP factors of the GHGs included in the PCF.	Yes
Fossil emissions (per declared unit)	The emissions resulting from the combustion of fossil fuels, as per declared unit of the PCF, in kg CO_2e per declared unit.	Yes
Fossil carbon content	Fossil carbon amount embodied in the product, in kg.	Yes
Biogenic carbon content	The amount of biogenic carbon contained within the product, in kg per declared unit.	Yes
dLUC emissions	Emissions resulting from recent (i.e., previous 20 years) carbon stock loss due to land conversion directly on the area of land under consideration, in kgCO_2e per declared unit. In the case of no value chain and/or data traceability to account for dLUC, companies shall account for sLUC emissions as a proxy for dLUC.	Yes, from 2025 onwards
Land management GHG emissions or removals (incl. non-CO_2 sources)	GHG emissions and removals associated with land-management-related changes, in kg CO_2e per declared unit. If changes in land carbon pools are not assessed, this decision shall be justified.	Yes, from 2025 onwards
Aircraft GHG emissions	GHG emissions resulting from aircraft engine usage for the transport of the product, per declared unit	No
Other biogenic emissions (excl. land-use change and land management)	All other biogenic GHG emissions associated with product manufacturing and transport that are not included in dLUC and land management, in kg CO_2e per declared unit. If such biogenic emissions are not included in the PCF, this decision shall be justified.	Yes, from 2025 onwards

PCF information		
Data attribute	**Description**	**Mandatory**
Biogenic CO_2 withdrawal	Biogenic carbon contained within the product converted to kg CO_2e per declared unit.	Yes, from 2025 onwards
iLUC emissions	Emissions resulting from recent (i.e., previous 20 years) carbon stock loss due to land conversion on land not owned or controlled by the company or in its supply chain, induced by change in demand for products produced or sourced by the company. iLUC emissions shall not be included as part of the PCF.	No
Methodology used to account for biogenic emissions and removals	Name of the standard followed to account for biogenic emissions and removals.	Yes, from 2025 onwards
Primary data share (PDS)	The percentage of the PCF that was calculated using primary activity and emissions data (see guidance in Section 4.2.1).	From 2025 onwards[a]
Secondary data sources	If secondary data was used to calculate the PCF, this attribute lists the data sources.	No
Exemption rules: %	Percentage of emissions excluded from PCF.	Yes
Exemption rules: explanation	Rationale behind exclusion of specific PCF emissions.	Yes
Packaging inclusion	Confirm inclusion or exclusion of packaging emissions in the PCF.	Yes
Packaging emissions	Emissions resulting from the packaging of the product, in $kgCO_2e$.	No
Cross-sectoral standard	Cross-sectoral standard used to calculate the PCF, e.g., GHG Product Lifecycle Standard.	Yes
Product- or sector-specific rules	If sector- or product-specific standards were used in the PCF calculation, they shall be disclosed here. If none were used, the attribute may be left empty.	No
Allocation rules	If relevant, a description of any allocation rules applied and the rationale explaining how the selected approach aligns with Pathfinder Framework rules (see Section 3.3.1.4).	No
Uncertainty assessment	Results, key drivers, and a short qualitative description of the uncertainty assessment, if applicable.	No

a. Please note, companies are mandated to report on either the PDS or the data quality indicators until 2025, when both will become mandatory.

Data quality indicators[a]		
Data attribute	**Description**	**Mandatory**
Coverage of data quality assessment	Percentage of PCF included in the data quality assessment based on the >5% emissions threshold.	From 2025 onwards
Technological representativeness[b]	Quantitative DQR based on the data quality matrix (Table 9), scoring the technological representativeness of the data[c] used for PCF calculation based on a weighted average of all inputs representing >5% of PCF emissions.	From 2025 onwards
Temporal representativeness	Quantitative DQR based on the data quality matrix (Table 9), scoring the temporal representativeness of the data used for PCF calculation based on a weighted average of all inputs representing >5% of PCF emissions.	From 2025 onwards
Geographical representativeness	Quantitative DQR based on the data quality matrix (Table 9), scoring the geographical representativeness of the data[2] used for PCF calculation based on a weighted average of all inputs representing >5% of PCF emissions.	From 2025 onwards
Completeness	Quantitative DQR based on the data quality matrix (Table 9), scoring the completeness of the data[2] collected for PCF calculation based on a weighted average of all inputs representing >5% of PCF emissions.	From 2025 onwards
Reliability	Quantitative DQR based on the data quality matrix (Table 9), scoring the reliability of the activity data collected for PCF calculation based on a weighted average of all inputs representing >5% of PCF emissions.	From 2025 onwards

a. Please note, companies are mandated to report on either the PDS or the data quality indicators until 2025, when both will become mandatory.

b. The term "technological" as used here refers to the technology of specific production processes. Throughout the rest of the Framework, this term is used to refer to IT.

c. When primary activity data has been used in the calculation of PCF and assuming that the primary data would be representative of the process under question, these data quality indicators should reflect the degree of representativeness of emission factors used in the calculation.

Assurance information		
Data attribute	**Description**	**Mandatory**
Assurance	Binary indicator stating whether the PCF has been assured in line with Pathfinder Framework requirements (Section 5).	Yes
Assurance coverage	Level of granularity of the emissions data assured: corporate level, product line, PCF system, or product level. Option to state "n/a" if no assurance has taken place.	No
Assurance level	Level of assurance applicable to the PCF: limited or reasonable. Option to state "n/a" if no assurance has taken place.	No
Assurance boundary	Boundary of the assurance, e.g., gate-to-gate or cradle-to-gate. Option to state "n/a" if no assurance has taken place.	No
Assurance provider	The name of the independent third party engaged to undertake the assurance.	No
Assurance completion date	The date at which the assurance was completed.	No
Assurance standard	Standard(s) against which the PCF was assured.	No
Assurance statement	A reference to the assurance statement that is used to prove the assurance of the PCF. This can be a PDF attachment or a digital signature. The technical specifications specify details on company identification and digital signature verification.	No
Assurance comments	Any additional comments that clarify the interpretation of the assurance.	No

Appendix C: Existing standards and guidance

This guidance builds on the development of emissions accounting standards of the GHG Protocol, ISO, and the European Commission. The table below summarizes some of the key standards and geographical focus of these entities.

Publisher	Geographical focus	Corporate level	Product level	Specific to given sectors	Specific to given products
European Commission	EU	Organizational Environmental Footprint (OEF)	PEF	OEF Sector Rules (e.g., for retail)	PEFCRs (e.g., for IT equipment)
ISO	Global	ISO 14064	ISO 14067 ISO 14040 ISO 14044	ISO 20915:2018 for steel products	PCRs (e.g., ISO 22526 for biobased plastics)
GHG Protocol (WRI/ WBCSD)	Global	Corporate, Scope 2, and Scope 3 standards	Product Life Cycle Standard	E.g., Agriculture Guidance Land Sector and Carbon Removal Guidance	PCRs (e.g., PCRs for concrete)

Appendix D: Assurance evidence pack

This evidence pack contains the information that companies should consolidate before undergoing product-level assurance in conformance with the Pathfinder Framework. It is structured along three dimensions of evidence central to verifying product-level emission disclosures:

1. **Data.** Evidence around the required data elements, sources, and quality of data used in the calculations
2. **Methodology.** Evidence around the calculation steps, results, and assumptions
3. **Governance.** Evidence around the underlying processes used during the calculations, including how data was stored, how quality was ensured, and how risks were mitigated

Each dimension is subdivided into five concrete elements that constitute the evidence pack for that dimension. As the maturity of companies' product-level emission reporting varies, the evidence pack distinguishes between elements that are likely to be needed at a **minimum** and elements that might be **optional** as evidence.

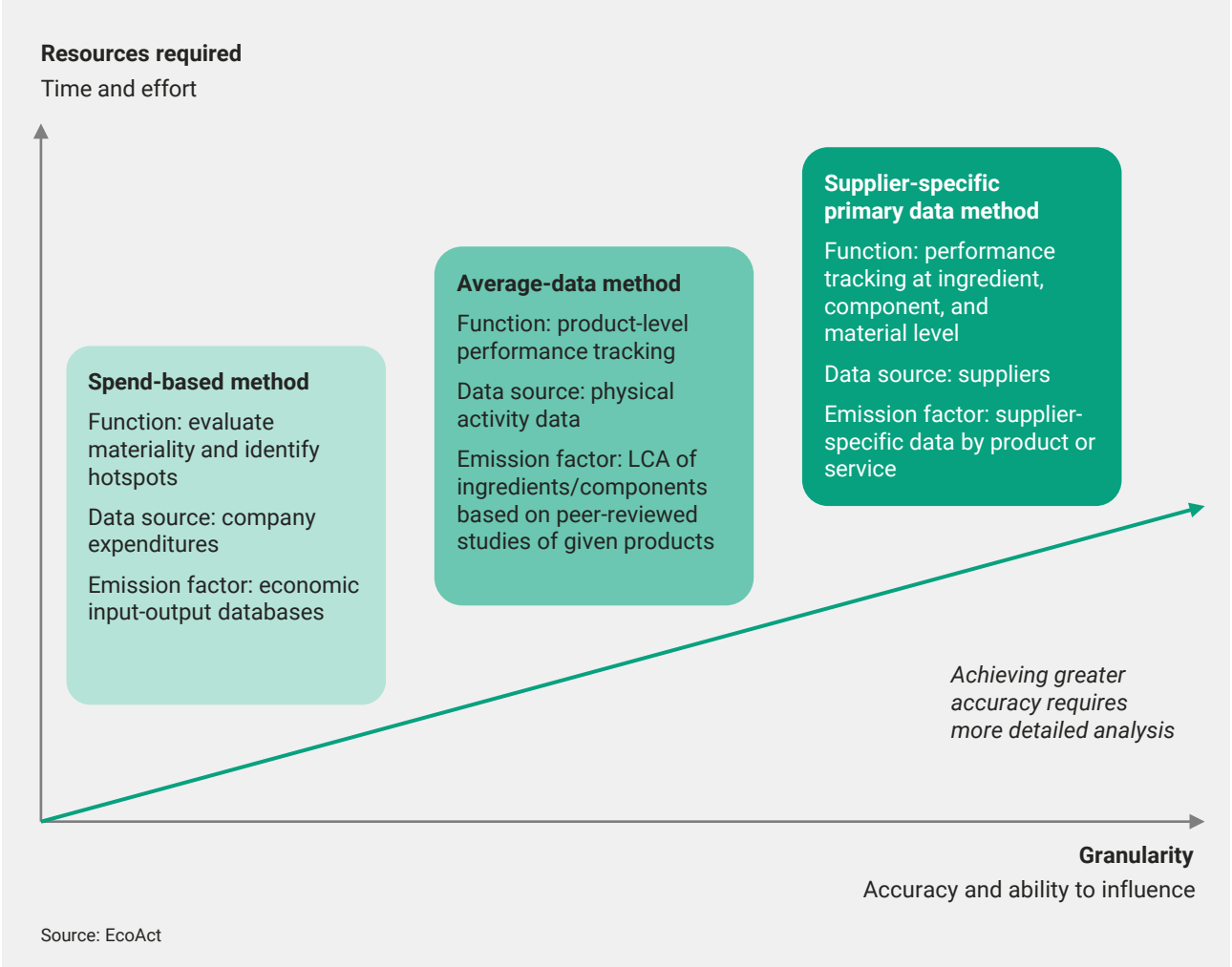
Data			
Element	**Description**	**Minimum**	**Optional**
Data collection	In order to perform a PCF calculation, companies are expected to identify all relevant GHG sources and map the activity data available for each	Inventory of all GHG sources and the relevant activity data broken down by site	N/A
Primary data sources	Understanding which of the GHG sources have been calculated via primary data collection is considered key for the purpose of the Pathfinder Framework	Comprehensive list of all primary data sources used	Additional information on how and when the data was accessed
Secondary data sources	Companies downstream want to ensure that secondary data used for the calculation comes from credible and globally recognized sources	Comprehensive list of all secondary data sources used	Additional information on how and when the data was accessed
Proxy data	Should primary and secondary data sources not cover the entirety of the studied PCF, proxy data can be used to fill in the gaps as long as this is documented transparently	List of proxy data used and rationale of application	Steps taken to ensure that proxy data used is minimized in the future
Data quality	As data quality shall only be assessed for GHG sources surpassing the defined 5% threshold, companies will need to give evidence of this exercise to ensure all material sources are covered in the assessment Companies will also need to give evidence of the data quality assessment statement	Results of materiality threshold assessment of PCF's GHG sources Overall data quality assessment statement	An individual data quality statement for each GHG source surpassing the materiality threshold

Methodology			
Element	**Description**	**Minimum**	**Optional**
Conformance	Standards followed will define the Framework requirements and thus the correctness of the steps taken by companies to calculate the PCF Companies will need to demonstrate alignment to Scope boundary conditions prescribed by the Framework	Comprehensive checklist of standard(s) requirements followed List of Scope boundary conditions	N/A
Calculation steps	It is essential for companies to be able to produce a list of calculation steps taken to convert activity data into GHG emissions for each life cycle stage included in the system boundary of the PCF	Comprehensive list of calculation steps per life cycle stage	N/A
Assumptions	A list of assumptions used in calculation to ensure completeness of calculation	Comprehensive list of assumptions made at each stage	N/A
Allocation	Downstream companies will want to understand whether allocation has taken place, and if so, what approach was used	Description of allocation approach followed	Evidence to confirm avoided allocation
Results	Results will allow verification parties to understand whether the calculation steps required by the standard have been completed accurately Ensures mass balance validation	Comprehensive list of all intermediate and final results	N/A

Governance			
Element	**Description**	**Minimum**	**Optional**
Data governance	In order to ensure replicability and facilitate knowledge transfer, companies should have in place a data governance plan mapping the data processes, ownership, and responsibilities, as well as documentation on the steps taken to consolidate and validate different data inputs, e.g., from different sites	Comprehensive map of all processes and responsibilities Comprehensive list of all data consolidation steps and rationale	N/A
Quality control	Internal mechanism in place to ensure quality control takes place and that responsibilities associated with it are clear	N/A	Comprehensive list of controls and responsibilities
Expertise	There is a need to ensure that the team employed to undergo the calculation process has sufficient expertise in the subject in order to minimize PCF misstatements	N/A	Total years of expertise within team employed to undergo PCF
Capacity	When asked, companies should be able to list internal and contracted team members (if any) responsible for the product footprint calculations	N/A	List of all responsible individuals
Risk management	Companies need to be able to identify potential shortcomings or pitfalls associated with the PCF calculation process in order to be able to address them	Comprehensive list of all risks and mitigation tactics	Progress on mitigation tactics employed

Appendix E: Scope 3 upstream accounting methods

Currently, three main methods are used to account for upstream Scope 3 emissions. These methods are defined by their accuracy and the type of data that the calculations are based on.



Source: EcoAct

Spend-based method

Companies calculating Scope 3 emissions for the first time tend to use data already being collected for other company processes, such as company expenditures, and to multiply these by a revenue intensity factor representing the Scope 1 and 2 emissions per dollar revenue for an activity or sector. While this method is less precise when quantifying emissions, it offers an initial overview of the focus areas within a value chain. This, in turn, allows companies to adapt their strategies to improve data quality based on the activities or products that have a greater impact. This method should only be seen as a first step in the quantification of Scope 3 emissions, after which companies should seek to improve data collection to achieve greater accuracy, as shown in Figure 2.

Average-data method

The second method uses physical metrics, i.e., primary activity data on material weight, fuel consumption, or distances traveled that allows the use of relevant secondary emission factors that are more specific to the nature and origin of these components when carrying out the calculations. These secondary emission factors can be found in process-based life cycle inventory databases and are present in the format of cradle-to-gate emission factors of the purchased good or service per unit of mass or unit of product.

While this is a step in the right direction, it continues to rely on industry averages, which hinders companies' abilities to determine the best-performing supplier for any given product or material or to understand how well company initiatives to reduce emissions (e.g., supplier engagement programs) are performing.

Supplier-specific data method

The ultimate goal, while requiring greater effort, is to obtain product-level emissions data directly from suppliers, as this would allow companies to collaborate with their supply chain to improve the efficiency of products and services purchased and accurately monitor the impact of these improvements on the footprint. This, in turn, can become a procurement criterion rewarding companies that are more sustainable or even supporting suppliers in their GHG reduction journeys.

Endnotes

1. Based on more than 50 selected stakeholders, including Shell, adidas, Pfizer, 3M, Volkswagen, GreenGauge, CDP, and McKinsey & Company.

2. Any reference in this document to the term "technology" shall be taken to refer to IT (as opposed to production technology).

3. ISO 14067:2018.

4. Existing overarching methods and standards, in contrast, do not provide a sufficient level of specificity. For instance, under the GHG Product Standard, two companies producing similar products can choose two different methods for allocating emissions, leading to results being incomparable.

5. To drive consistency, PACT is collaborating with several sectoral initiatives to build sector- and product-specific guidance in alignment with the Pathfinder Framework.

6. Prior to commencement, the list of work-in-progress PCRs by relevant program operators shall be consulted to avoid duplication. Any new development activities should further be brought to the attention of the Partnership for Carbon Transparency.

7. Together for Sustainability (2022), The Product Carbon Footprint Guideline for the Chemical industry.

8. World Resources Institute/World Business Council for Sustainable Development, GHG Protocol (2013), Required Greenhouse Gases in Inventories; Accounting and Reporting Standard Amendment.

9. This guidance allows for a one-year grace period to give companies sufficient time to update their calculations and systems to the latest characterization factors provided by the IPCC. Please find the IPCC 2021 update in the following link (page 1034).

10. The Pathfinder Framework uses a value chain perspective to account for and exchange product life cycle emissions. As such, the Framework organizes a company's emissions into three major categories: (i) upstream emissions: indirect GHG emissions that occur in the value chain prior to the processes owned or controlled by the reporting company; all upstream transportation emissions are also included as part of upstream emissions; (ii) direct emissions: GHG emissions from the processes that are owned or controlled by the reporting company; (iii) downstream emissions: indirect GHG emissions that occur in the value chain following the processes owned or controlled by the reporting company.

11. Accounting for and reporting for transportation emissions is described further in **Section 3.3.2.2**.

12. If bioenergy biomass is used as a feedstock material, please refer to **Section 3.3.2.1** for reporting guidance.

13. These rules are aligned with PAS2050 cut-off criteria. While alignment with other frameworks was sought, the divergence found across them led to this guidance aligning with the most lenient approach to ensure that PCFs following other frameworks are still compliant with these exemption rules.

14. The Pathfinder Network will help facilitate direct access to these.

15. ISO 14044.

16. GHG Product Standard (page 67).

17. GHG Product Standard (Table 9.1).

18. Please note this is an arbitrary number agreed on with other PCF calculation initiatives that is intended to reflect a significant divergence in the value of the different co-products.

19. Please refer to ISO 14067:2018 Section 6.4.8 for further information on how to account for biogenic CO_2e withdrawals and the temporary storage in product carbon pools.

20. Please note that aircraft GHG emissions under certain circumstances in high altitudes have additional climate impacts because of physical and chemical reactions with the atmosphere. For more information on GHG emissions from aircraft, see the IPCC Guidelines for National Greenhouse Gas Inventories and the IPCC Special Report on Aviation.

21. See EPD International for detailed criteria on when the end-of-waste state is achieved.

22. This method is also known as the 100-0 method.

23. World Resources Institute/World Business Council for Sustainable Development, GHG Protocol (2013), Technical Guidance for Calculating Scope 3 Emissions.

24. World Resources Institute/World Business Council for Sustainable Development, GHG Protocol (2013), Technical Guidance for Calculating Scope 3 Emissions.

25. The Pathfinder Network will help facilitate access to such emission factors.

26. World Resources Institute/World Business Council for Sustainable Development, GHG Protocol (2013), Technical Guidance for Calculating Scope 3 Emissions.

27. Specific guidance focused on data sources for transportation can be found in **Section 3.3.2.2**.

28. While this guidance advocates for the use of primary data, in some cases primary data may be associated with high uncertainty and/or measurement inaccuracies, thus making secondary data more representative of activity data or emission factors.

29. More information on validation of databases can be found in Section 2.3 of the Global Guidance for Life Cycle Assessment Databases (2011).

30. Canals et al. (2011), Approaches for Addressing Life Cycle Assessment Data Gaps for Bio-based Products.

31. Assuming company-specific activity data has been used in the calculation of the PCF and that the data are representative of the process in question, the assessment of this data quality indicator shall be based on the degree of representativeness of the emission factors used in the calculation.

32. See endnote above.

33. See endnote above.

34. Retrieved from ISAE 3000 and related standards such as ISAE 3410.

35. GHG Product Standard (page 96).

36. In the context of this guidance, SMEs are defined in accordance with the latest EU recommendation 2006/361 criteria and thresholds, where SMEs are defined as companies that employ fewer than 250 persons and have an annual turnover not exceeding €50 million and/or an annual balance sheet total not exceeding €43 million.

37. UN Statistics Division (September 22, 2021), Economic statistics. Retrieved from https://unstats.un.org/unsd/classifications/Econ/cpc.

38. New compared to version 1.0.

39. Retrieved from ISO 14067:2018:17.

40. May also be referred to as reference year.

Disclaimer

The Pathfinder Framework is designed to ease GHG accounting and encourage businesses to exchange verified primary data on product carbon emissions across the supply chain. It has been developed in a multi-stakeholder process, including experts from business, industry initiatives, standard-setting and reporting bodies, government and nongovernmental organizations. The process was led by the World Business Council for Sustainable Development (WBCSD), within the context of its Partnership for Carbon Transparency. McKinsey & Company, the global management consulting firm, provided analytical insights and support to the Partnership for Carbon Transparency.

While WBCSD encourages the use of the Pathfinder Framework by all corporations and organizations, the preparation and publication of reports or program specifications based fully or partially on these guidelines is at the discretion of each entity producing them. Neither WBCSD nor any other individuals who contributed to these guidelines assume responsibility for any consequences or damages resulting directly or indirectly from its use (e.g., in the preparation of reports, program specifications or the use of reports based on these guidelines).

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About WBCSD

WBCSD is the premier global, CEO-led community of over 200 of the world's leading sustainable businesses working collectively to accelerate the system transformations needed for a net zero, nature positive, and more equitable future.

We do this by engaging executives and sustainability leaders from business and elsewhere to share practical insights on the obstacles and opportunities we currently face in tackling the integrated climate, nature, and inequality sustainability challenge; by co-developing "how-to" CEO-guides from these insights; by providing science-based target guidance including standards and protocols; and by developing tools and platforms to help leading businesses in sustainability drive integrated actions to tackle climate, nature, and inequality challenges across sectors and geographical regions.

Our member companies come from all business sectors and all major economies, representing a combined revenue of more than $8.5 trillion and 19 million employees. Our global network of almost 70 national business councils gives our members unparalleled reach across the globe. Since 1995, WBCSD has been uniquely positioned to work with member companies along and across value chains to deliver impactful business solutions to the most challenging sustainability issues.

Together, we are the leading voice of business for sustainability, united by our vision of a world in which 9+ billion people are living well, within planetary boundaries, by mid-century.

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About PACT

PACT is seeking to accelerate decarbonization through the creation of transparency on emissions in the value chain.

PACT provides a forum for stakeholders to jointly tackle this challenge, uniting businesses from across industries, technology players, industry-focused initiatives, standard-setting bodies, reporting organizations, and regulators in their shared mission. Jointly, the PACT community defines and publishes the necessary methodological and technological basis for emissions data exchange, integrating existing standards and approaches and creating a trusted and holistic foundation.

PACT is hosted by WBCSD and supported by its knowledge partner, McKinsey Sustainability, as well as its technology partner, SINE Foundation.

www.carbon-transparency.com

About McKinsey Sustainability

McKinsey Sustainability is McKinsey's client-service platform with the goal of helping all industry sectors transform to get to net zero by 2050 and to cut carbon emissions by half by 2030. McKinsey Sustainability seeks to be the preeminent impact partner and adviser for their clients, from the board room to the engine room, on sustainability, climate resilience, energy transition, and environmental, social, and governance (ESG). It leverages thought leadership, innovative tools and solutions, top experts, and a vibrant ecosystem of industry associations and knowledge partnerships to lead a wave of innovation and economic growth that safeguards our planet and advances sustainability.

About SINE Foundation

The SINE Foundation is a tech for good organization founded by progressive entrepreneurs, academic experts, and software engineers. SINE designs and implements the foundation for lasting data collaboration—delivered as ready-to-use governance tools and open-source software. The nonprofit foundation supports global organizations to identify, initiate, and maintain use cases for data collaboration within complex multi-stakeholder environments.

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